MAINTENANCE ENGINEERING

In Plants, Mills, and Factories

FOR THE past year or so credit has been much restricted, money difficult to obtain. Despite adverse conditions, however, many industrial plants that have ample reserves or strong banking connections have spent large sums in putting buildings and equipment in the proper condition for maximum economy of production. Such plants inevitably have an advantage over competitors who have not adopted the same measures to strengthen their position. In behalf of many that have not taken these steps be it said that the difficulty of obtaining needed capital, or the inability to do so, has prevented them from carrying out well-planned programs for plant rehabilitation.

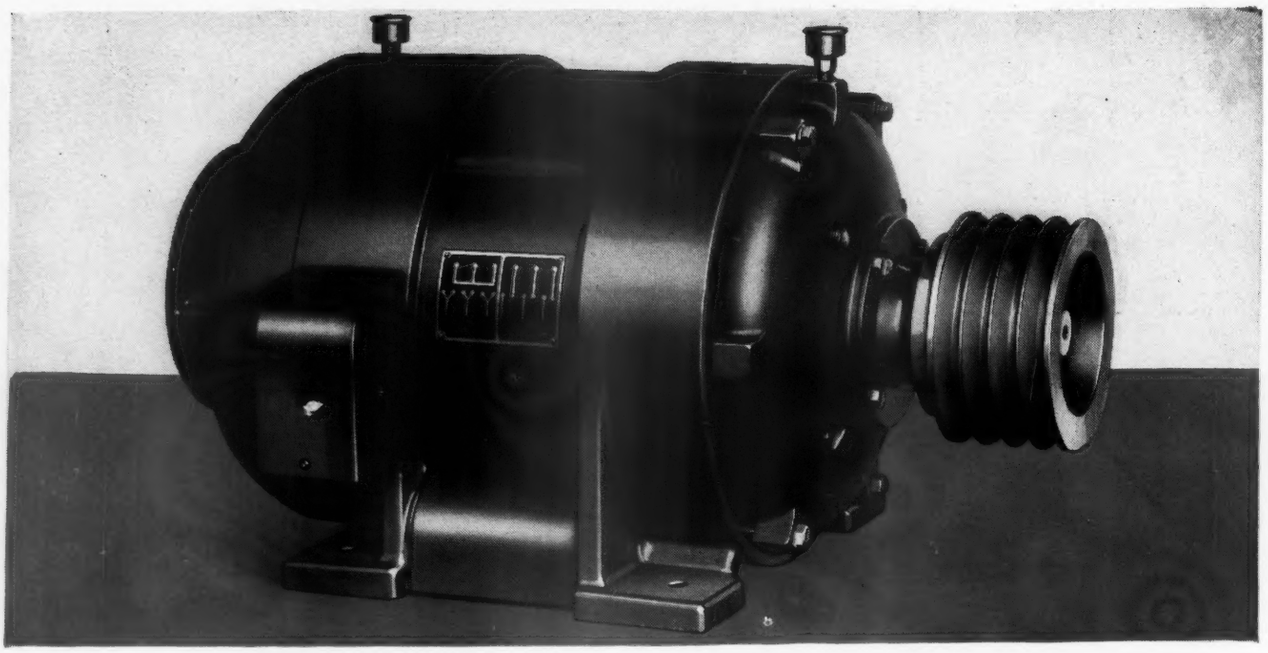
Formation of the Reconstruction Finance Corporation and the passage of the Glass-Steagall emergency banking bill should do much to remove this handicap. The purpose of these measures is to supply credit in ample amount — the medicine that is sorely needed by sick business and industry.

It is now up to business and industry to determine whether they will take advantage of these constructive measures and thus permit them to exert their full influence in restoring normal business conditions.

McGraw-Hill Publishing Company, Inc.

25 cents a copy

APRIL
1932



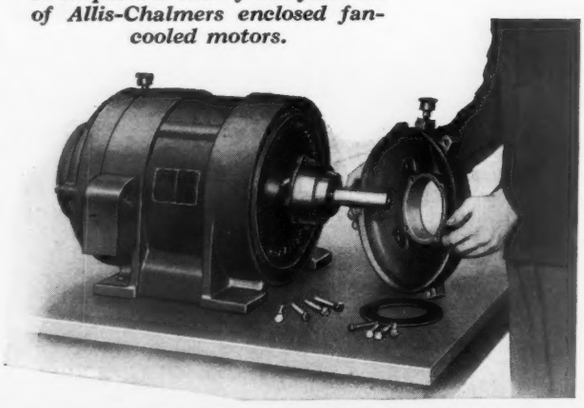
Your Maintenance Man Knows
the Value of these Enclosed Motors

HE knows that where dust, dirt, moisture, dripping water, or destructive gases are present . . . . those drives in out of the way places where motor windings become clogged or moisture soaked . . . . there, Allis-Chalmers enclosed fan-cooled motors reduce trouble and operating expense.

He knows that sturdy construction, liberal design, and unexcelled insulation are features of Allis-Chalmers motors and that the enclosed-fan-cooled type, while thoroughly protected, is readily accessible.

Allis - Chalmers enclosed fan - cooled motors approved by the Underwriters for dusty locations are described in Leaflet 2124. Explosion-proof motors, also approved, are described in Leaflet 2125-A.

Complete and ready accessibility to all parts is one of the features of Allis-Chalmers enclosed fan-cooled motors.



Allis-Chalmers Mfg. Co., Milwaukee

ALLIS-CHALMERS MOTORS

MAINTENANCE ENGINEERING

Founded 1882—McGraw-Hill Publishing Company, Inc.

APRIL
1932

Repair Shop Procedure

JOHN B. TUFTS
President, Electric Motor Repair Company
Springfield, Mass.

MOTOR repairing does not differ materially from product manufacturing. In both cases it is important that the necessary operations be performed with the least amount of waste time and with a minimum of effort. The answer in both cases, also, is organization. Our set-up is simple. The shop is under the direct supervision of a shop superintendent. All workmen report to him and he reports to the president.

The shop and office occupy an area of 13,500 sq.ft. in a modern four-story building. The floor is divided into two distinct parts, (see floor plan, page 148). One section includes the office, stockrooms for motors, pulleys, and winding materials, receiving bench, testing panels, stripping and cleaning room, and machine shop. The remainder of the floor, a somewhat wider bay at one end, houses the winding department.

Shop equipment and materials are so located that a motor undergoing repairs moves from one operation and one department to the next without back-tracking and with a minimum of handling operations. Hand lift trucks are used whenever a motor must be moved for any distance. Wall cranes and chain blocks are installed in the machine shop and over the varnish dipping tank. A monorail track and a 1-ton chain hoist are installed over the cleaning tank in the stripping room.

A motor entering the shop is taken from the street level to the second floor by a 5-ton freight elevator close to the receiving bench. One feature of this arrangement is worth mention. Motors to be repaired are usually delivered on motor trucks. The freight elevator at the street entrance can be leveled with the floor of the truck and the motor transferred to the elevator by a hand lift truck.

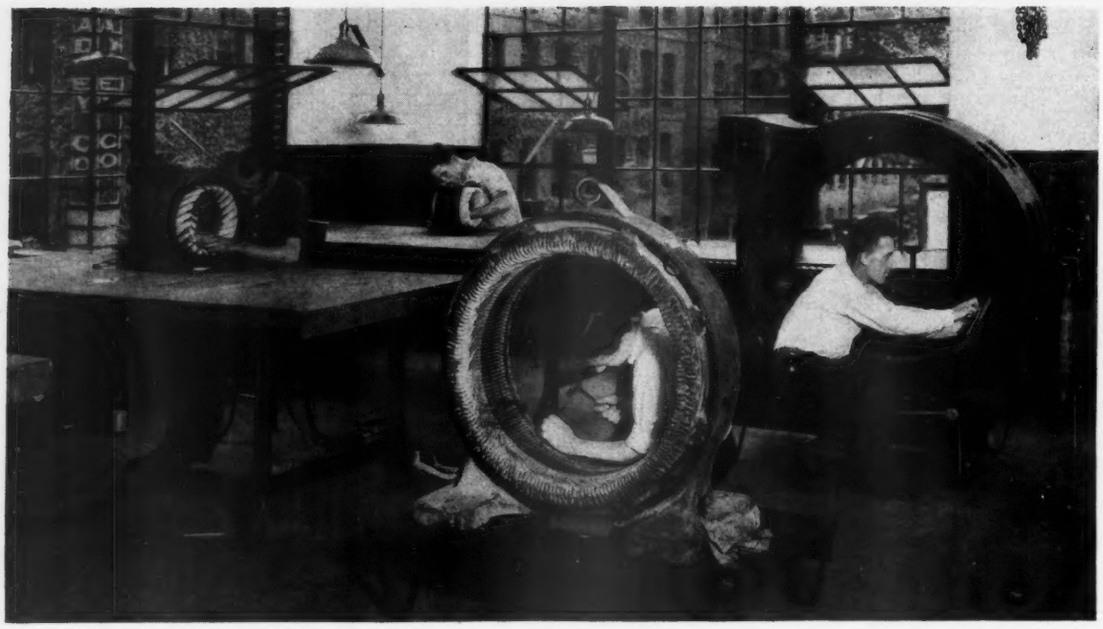
At the receiving bench the motor is placed on a skid and given a tag (Fig. 1) bearing the job or shop number. This tag accompanies the motor until all repairs are completed. Duplicate tags are attached to the various parts, such as pulleys, bases, and end shields, as these parts are removed during the process of dismantling and stored or sent to the proper department for repair.

From the receiving bench the motor is taken to the testing board, immediately behind the bench, where a thorough test is made to determine the nature and extent of the repairs necessary. Motor nameplate and winding data are transferred to a motor data record, (Fig. 2). This form, which is kept in a loose-leaf binder, is filled in in duplicate. One copy is retained by the shop superintendent and the other goes to the office. When completed it contains a record of the repairs made, parts and materials used, and the final test data. On out of town shipments, where the order is received in advance of the equipment, a record is made on Fig. 2 and more complete details are added by the superintendent when the motor is received.

When a customer requests a quotation, or when a motor is received in an especially poor condition and the cost of repairs will be excessive, a "Special Repair Report," (Fig. 3) is filled out by the shop superintendent and submitted to the office for approval before work is begun.

Repair material needed for a specific motor, and which is not ordinarily kept in stock, is ordered on the requisition shown as Fig. 4. The request for such material originates at the receiving bench, at the time the motor is tested. The material, however, is ordered by the stock clerk and charged against the job number on requisition. Material used by the workman is ordered from stores on a general shop requisition. A recapitulation of these daily or shop requisitions is kept up to date by the office.

Two storerooms are maintained. One, located just beside the entrance



One corner of the winding department showing two of the five winding benches in use.

JOB No. M 1316

Date Rec. 12/2/31 Date Pro.

Name Eaton Paper Co.

WINDING DATA

Wire	Length of Coil
No. Slots	Coils out from Lam.
Coils per Slot	Length of Leads
Turns per Coil	End Coil Connection Top
Coils per Group	
Coil Pitch	
Wires in Hand	
Connection	

Date Signed

Fig. 1 — Motor Shop Tag. This accompanies the motor throughout the shop until repairs are completed.

to the winding department (see layout), contains stocks of all the materials ordinarily needed for making electrical and mechanical repairs. The other stockroom, adjacent to the office, contains stocks of motor pulleys, bases, and rewound and reconditioned motors for rental and sale.

After the preliminary test the motor, still on a skid, is moved to a storage bay and here dismantled. Bearings are inspected and tested for wear. If new bearings are necessary the end shields are taken to the machine shop, directly across the aisle, and the bearings are replaced. Note is made of other mechanical repairs needed and the motor parts or instructions are given to the machine shop.

One side of the storage section is occupied by a row of steel shelves upon which rest metal bins or trays about 14 in. wide, 18 in. long and approximately 6 in. high. The front of each bin has a holder into which is inserted a card bearing the same number as the motor tag. Motor parts such as end shields, pulleys, terminal blocks, and lead clamps, taken from the motor before the windings are stripped, are placed in the proper bin and left there until the motor is reassembled.

From the storage bay the motor goes to the cleaning and stripping room where the old coils are removed and the motor cleaned and made ready for the insertion of new winding.

After the old coils are removed the motor frame is cleaned with naphtha applied under pressure by a spray gun. We have found that this method has several advantages: It speeds up the work, does a better job of cleaning, and conserves the naphtha.

Naphtha was selected as the cleaning agent because we found that gasoline contained too much oil, which, if left on the motor frame, would prove injurious to new coils and insulation. Motors that have been used in especially dusty or dirty locations are boiled in a cleaning solution in a tank at one end of the room.

While the motor is being stripped, the winding department foreman is called in and the coil data are checked by him and recorded on a coil data card (Fig. 5). This record is sent to the office and checked against the cards in the permanent file. If a similar motor has been rewound before, the details are sent to the winding department where coils are made and insulation cut while the motor is being stripped and cleaned. If a new motor is being handled coil data are recorded in the same manner and a

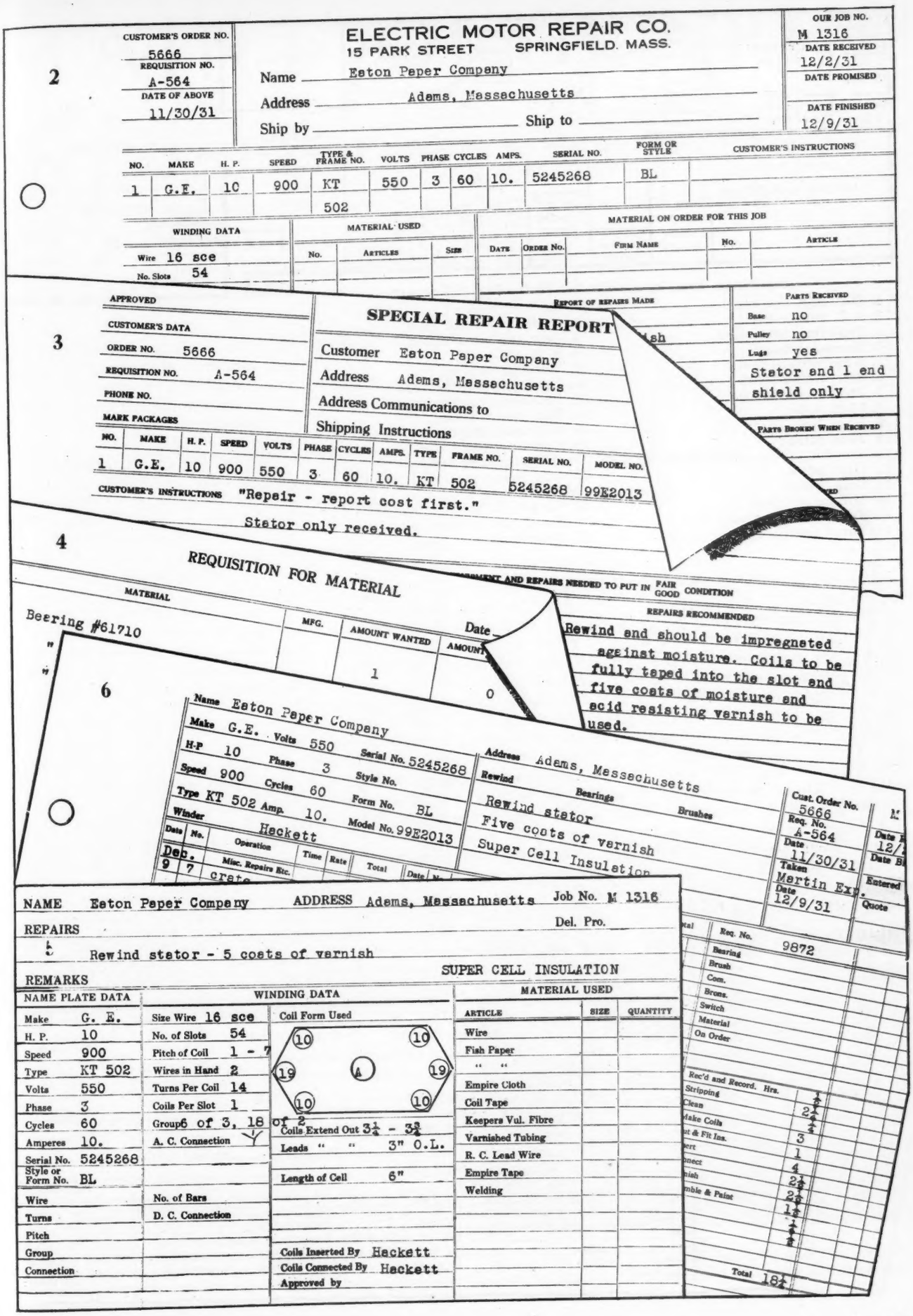
Fig. 2—Motor Data Record. Filled in by the shop superintendent at the receiving bench. When completed this form shows a complete record of the job with the exception of time and labor charges.

Fig. 3—On jobs that require an unusual amount of time or labor this form is filled in and submitted to the office for a report to customer before work is begun.

Fig. 4—Requisition form used by the office for ordering materials for stock. It is filled in by the shop superintendent.

Fig. 5—Coil Data Card. Master card of the order system. In addition to the winding data, the reverse side shows a cost summary which is used to make out the customer's bill.

Fig. 6—Cost sheet for large motors. Gives complete tabulation of the labor charges for each operation.



2

CUSTOMER'S ORDER NO. 5666
REQUISITION NO. A-564
DATE OF ABOVE 11/30/31

ELECTRIC MOTOR REPAIR CO.
15 PARK STREET SPRINGFIELD. MASS.

Name Eston Peper Company
Address Adems, Massachusetts
Ship by ____ Ship to ____

OUR JOB NO. M 1316
DATE RECEIVED 12/2/31
DATE PROMISED
DATE FINISHED 12/9/31

NO.	MAKE	H. P.	SPEED	TYPE & FRAME NO.	VOLTS	PHASE	CYCLES	AMPS.	SERIAL NO.	FORM OR STYLE	CUSTOMER'S INSTRUCTIONS
1	G.E.	10	900	KT 502	550	3	60	10.	5245268	BL	

WINDING DATA
Wire 16 sce
No. Slots 54

MATERIAL USED

No.	ARTICLES	SIZE

MATERIAL ON ORDER FOR THIS JOB

DATE	ORDER NO.	FIRM NAME	No.	ARTICLE

3

APPROVED
CUSTOMER'S DATA
ORDER NO. 5666
REQUISITION NO. A-564
PHONE NO.
MARK PACKAGES

SPECIAL REPAIR REPORT

Customer Eston Paper Company
Address Adems, Massachusetts
Address Communications to
Shipping Instructions

REPORT OF REPAIRS MADE
...ish

PARTS RECEIVED
Base no
Pulley no
Lugs yes
Stator and 1 end shield only

PARTS BROKEN WHEN RECEIVED

NO.	MAKE	H. P.	SPEED	VOLTS	PHASE	CYCLES	AMPS.	TYPE	FRAME NO.	SERIAL NO.	MODEL NO.
1	G.E.	10	900	550	3	60	10.	KT	502	5245268	99E2013

CUSTOMER'S INSTRUCTIONS "Repair - report cost first."
Stator only received.

4

REQUISITION FOR MATERIAL

...MENT AND REPAIRS NEEDED TO PUT IN FAIR GOOD CONDITION

REPAIRS RECOMMENDED
Rewind and should be impregnated against moisture. Coils to be fully taped into the slot end five coats of moisture end acid resisting varnish to be used.

MATERIAL	MFG.	AMOUNT WANTED	AMOUNT
Bearing #61710		1	0
"			
"			

Date ____

6

Name Eston Peper Company
Make G.E. Volts 550 Serial No. 5245268
H-P 10 Phase 3 Style No.
Speed 900 Cycles 60 Form No. BL
Type KT 502 Amp. 10. Model No. 99E2013
Winder Hackett

Date	No.	Operation	Time	Rate	Total
Dec. 9	7	Misc. Repairs Etc. crate			

Address Adems, Massachusetts
Rewind Bearings Brushes
Rewind stator
Five coats of varnish
Super Cell Insulation

Cust. Order No. 5666
Req. No. A-564
Date 11/30/31
Taken Martin Exp.
Date 12/9/31

Date R. 12/...
Date Bl...
Entered
Quote

Req. No. 9872
Bearing
Brush
Com.
Brons.
Switch
Material
On Order

Rec'd and Record. Hrs.
Stripping 1
Clean 2 1/4
Make Coils 1/4
...t & Fit Ins. 3
...ert 1
...nect 4
...nish 2 1/2
...mble & Paint 2 1/2
1 1/2
1/4
1/2
Total 18 1/4

NAME Eston Peper Company ADDRESS Adems, Massachusetts Job No. M 1316
Del. Pro.
REPAIRS
1. Rewind stator - 5 coats of varnish
SUPER CELL INSULATION
REMARKS

NAME PLATE DATA

Make	G. E.
H. P.	10
Speed	900
Type	KT 502
Volts	550
Phase	3
Cycles	60
Amperes	10.
Serial No.	5245268
Style or Form No.	BL
Wire	
Turns	
Pitch	
Group	
Connection	

WINDING DATA

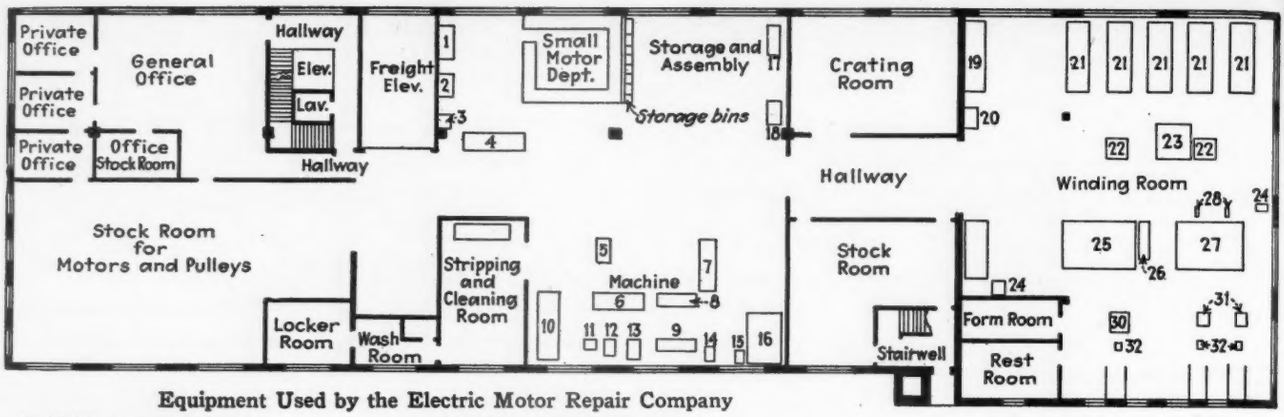
Size Wire	16 sce
No. of Slots	54
Pitch of Coil	1 - 7
Wires in Hand	2
Turns Per Coil	14
Coils Per Slot	1
Group	6 of 3, 18 of 2
A. C. Connection	Y
No. of Bars	
D. C. Connection	

Coil Form Used

Coils Extend Out 3 1/4 - 3 3/4
Leads " " 3" O.L.
Length of Coil 6"
Coils Inserted By Hackett
Coils Connected By Hackett
Approved by

MATERIAL USED

ARTICLE	SIZE	QUANTITY
Wire		
Fish Paper		
" "		
Empire Cloth		
Coil Tape		
Keepers Vul. Fibre		
Varnished Tubing		
R. C. Lead Wire		
Empire Tape		
Welding		



Equipment Used by the Electric Motor Repair Company

1. D.C. m.g. test panel
2. A.C. test board
3. Superintendent's desk
4. Receiving bench
5. 5-ton vertical press
6. Steel frame bench
7. Steel frame bench
8. 15-in. lathe
9. 10-in. lathe
10. 24-in. lathe
11. Portable power metal hacksaw
12. Drill press
13. Drill press
14. Milling machine
15. Small electric oven
16. Large electric oven
17. Air compressor
18. Portable varnish tank
19. Test and work bench
20. M.G. set
21. Winding benches
22. Insulation cutting shears
23. Insulation cutting table
24. Foot punch press
25. Coil insulating table
26. Coil spreader
27. Coil insulating table
28. Coil taping machine
29. Power bandsaw
30. Large coil winding machine
31. Small coil winding machines
32. Wire tension devices

sample coil is made for the guidance of the winder.

The coil data card (Fig. 5), is the master card of the system and, when repairs are completed, becomes part of the permanent office file to be used as a guide for similar repair jobs in the future. When completed it contains the nameplate data, winding and coil details, materials used, and a summary of the time and labor charges. These charges are listed on the reverse side of the card and show the worker, the elapsed time, and total cost of each operation. This information is obtained from the requisitions and job sheets made out in the shop as the work progresses, and is used to draw up the customer's bill.

When the motor has been cleaned, stripped, and dried, it is taken to the winding department.

In connection with this department one iron-clad rule is enforced at all times. No motors or motor parts are allowed in this section until they have been cleaned thoroughly of all grease, dirt, oil, acid, or other foreign matter which might prove injurious to new insulation or coils.

From the storage bench at the entrance to the winding room the motor is taken to a bench where cell insulation and coils are inserted.

From the standpoint of endurance, no item that enters into motor construction is of more vital importance than the insulation. Experience repair men know that almost all insulation breakdowns occur at the end of the slot where the cell lining extends unsupported and unprotected beyond the sharp edges of the stator laminations. It was the large number of such failures that led us to develop the coil insulation which we use on all our semi-closed slot motor rewind jobs, and which we call "Super Cell Insulation." This insulation is composed of a strip of varnished cambric placed between two pieces of insulating paper. At each end of the strip of paper that goes into the bottom of the cell is attached a reinforcing strip of woven cloth. After the coils have been inserted, vulcanized fiber wedges are driven into position. These wedges are curved so that when inserted in the slots they fold and hold the cell lining tightly about the coils.

After the insulation and coils are in place the motor is turned over to a workman who does nothing but connect the coils and put sleeving on the group connections. The winding data on the motor tag are used as a guide. Terminal blocks or lead clamps are obtained from the storage bin and the new windings are then given a growler test for shorts. They

(Please turn to page 162)

Fig. 7—Combination job and cost sheet used by the small motor department.

CUSTOMER'S ORDER NO. R-1230-8 REQUISITION NO. DATE OF ABOVE 12/30/31

ELECTRIC MOTOR REPAIR CO.
15 PARK STREET SPRINGFIELD, MASS.

DATE PROMISED

S. M. JOB NO. 3613 DATE RECEIVED 12/31/31 DATE BILLED DATE FINISHED 1/2/32

Name White & Wyckoff Manufacturing Company
Address Holyoke, Massachusetts
Ship by Ship to Bill to

NO.	MAKE	H.P.	SPEED	TYPE & FRAME NO.	VOLTS	PHASE	CYCLES	AMPS.	SERIAL NO.	FORM OR STYLE	CUSTOMER'S INSTRUCTIONS
1	B & D	½"	600	K	110	AC - DC		6.	K 34058		Repair Drill

MATERIAL AND PARTS USED

NO.	ARTICLE	MAKE	SIZE OR TYPE NO.	UNIT COST	UNIT HP	TOTAL COST	TOTAL HP
	Arm. - Rotor						
	Bearings						
4	Brushes	#834					
	Brush Springs						
	C. Switch Sts. Ft.						
	" " Rot. Ft.						

LABOR

DATE	NO.	OPERATION	TIME	RATE	TOTAL
12/ 31	9	inspect	½		
31	9	take apart	½		
1/8	9	install new parts			
		clean & overhaul	2		

PARTS RECEIVED: Base, Pulley, Leads

PARTS BROKEN

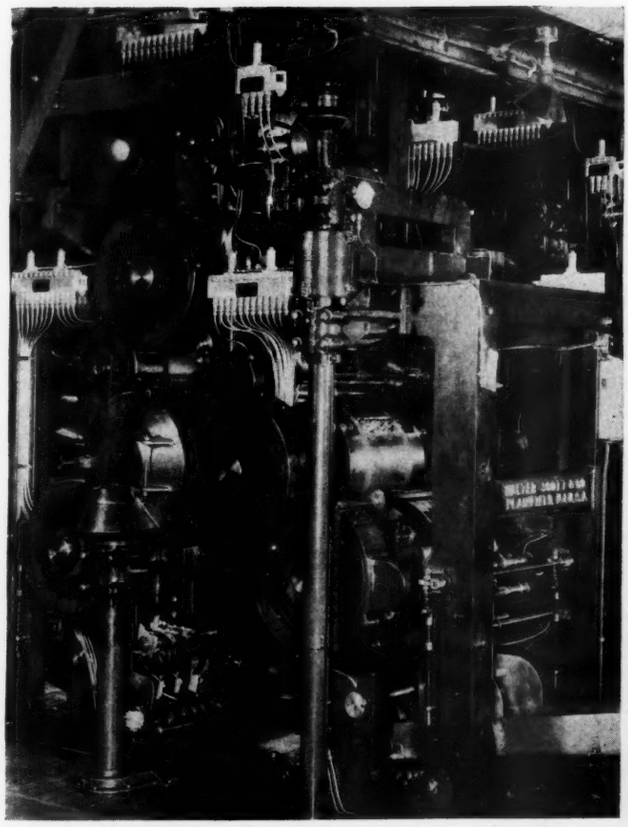
MAINT-O-GRAPHS

Ways of increasing efficiency of equipment ◆ Ideas that will help plant men

News of books and events ◆ ◆ Practical solutions of plant problems

Unusual developments in apparatus design

CONTRIBUTIONS ARE WELCOME



Oiling 568 Places Simultaneously

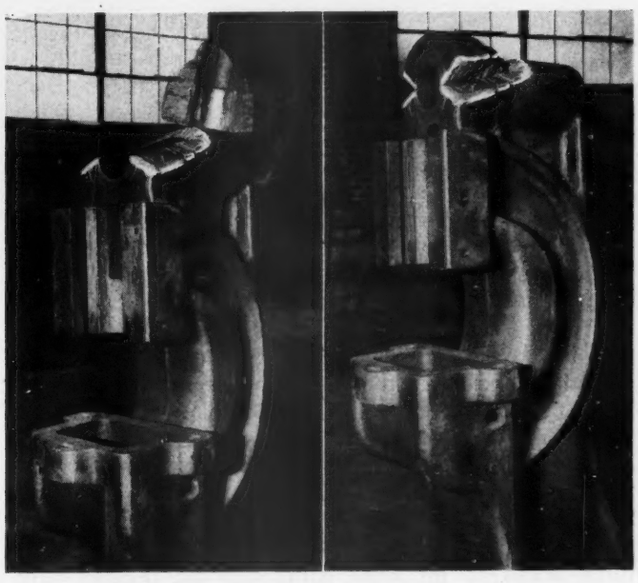
SOURCE, Gits Bros. Manufacturing Company

On this press there are 568 places where oil must be deposited every three minutes. Compressed air operated gravity feed oilers do the job. At the designated time an electric switch admits a charge of compressed air into each receptacle, which raises a bar from the bottom and brings up a scoopful of oil. The oil drops through openings in the top of the nipples and flows by gravity to the bearings. Oilers can be adjusted to give anywhere from ¼ of a drop to 10 drops every operation.

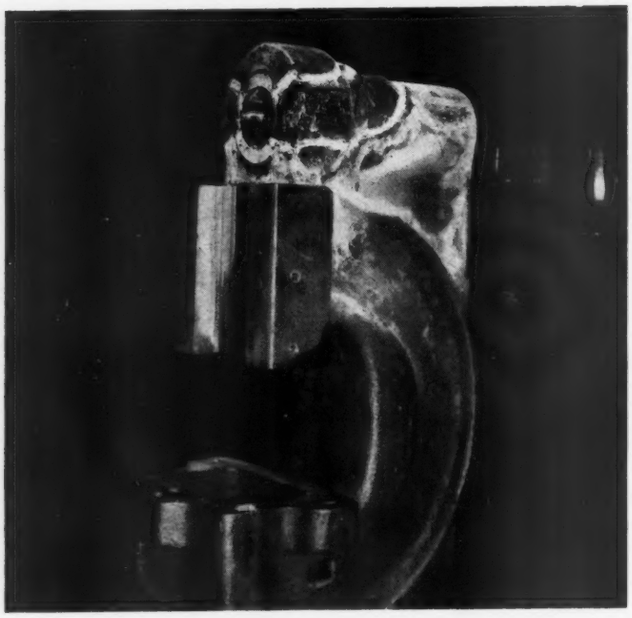
Bronze Welding Reclaims Large Press Casting

SOURCE, The American Brass Company

In the plant of a New England manufacturer a cast-iron power press frame, weighing about 2,500 lb., fractured completely through the main shaft bearing because the casting was overloaded so that it was subjected to stresses higher than it could stand. As shown below, the rupture was clean and extended through half the length of the shaft bearing; a piece of metal nearly one foot long was detached in the break. As the press was vital to production it was essential to restore it to service with a minimum loss of time. A new casting would have involved several weeks' delay and an expenditure of approximately $500. Therefore a welding expert was called in. He recommended bronze



Heavy press casting with fractured bearing caused by overload. Some casting with a V chipped out around the line of break to receive the weld.



The finished job containing 22 lb. of welding bronze.

welding as the least expensive and quickest method of making the repairs and received the job.

His first step was to prepare the break for welding by chipping out a V, 4 in. wide and 4 in. deep, completely around the line of fracture. This preparatory work was finished in five hours. It was not necessary to preheat the casting extensively. It was necessary, however, to take the chill out of the cast iron in order to eliminate the possibility of warping or fracture caused by expansion and contraction. This heating was accomplished by applying the inner cone of the acetylene flame on and around the areas adjacent to the break. After the welding areas had been heat-soaked thoroughly welding was commenced.

Because the position of the work, as well as the direction of welding, has much to do with a successful job the casting was slung in a horizontal position. This position of the casting allowed the weld in the fracture to be built up vertically. The piece that had been broken away was held in place by a U-shaped yoke clamped to the casting.

The cast iron comprising the weld area was then brought to a bright red heat, and the bronze was melted on by the outer envelope of the flame, with the inner cone held about $\frac{1}{4}$ in. away from the welding rod. This procedure eliminated the danger of burning the bronze. With the cast iron heated to a bright red, the bronze flowed ahead of the weld and tinned perfectly.

A neutral oxy-acetylene flame was directed on the welding area several inches ahead of the weld to maintain the cast iron at the correct welding temperature. The method of using the separate preheating torch ahead of the weld eliminated the necessity for using a furnace, or for preheating the entire casting.

After the break was built up with bronze for a distance of 4 in., the clamp that held the broken member in place was removed. The work progressed rapidly from this point, and as many as three rods at a time were melted in the weld. The work was rotated in a manner that maintained the direction of the weld in a vertical position. This method also permitted a more uniform temperature control in that the flow of heat always proceeded in one direction.

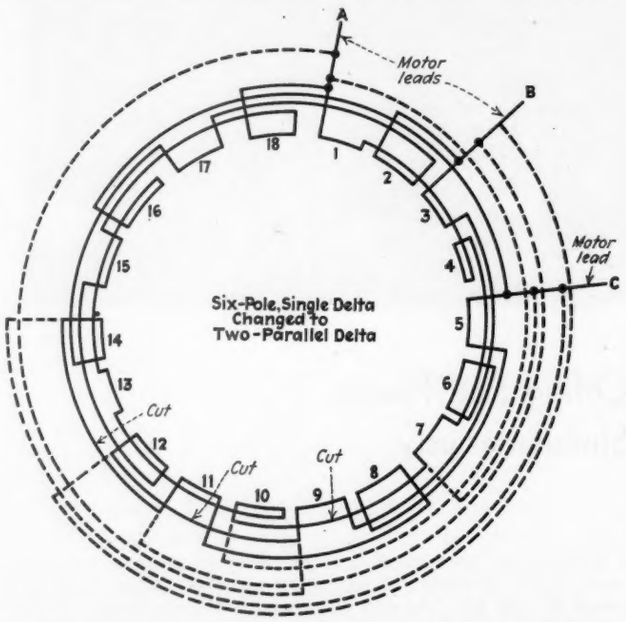
When the job was finished the broken piece in the shaft bearing was found to be in perfect alignment and no machining on the inside of the shaft was required. The outer surface of the weld was smoothed off with a grinding wheel.

The necessary material was 22 lb. of $\frac{1}{4}$-in. bronze welding rod and 240 cu.ft. each of oxygen and acetyene. The total cost of welding this bearing was approximately 10 per cent of the cost of a new casting.

Changing A. C. Motor Connection Enables It to Pull Load

GRADY H. EMERSON, Birmingham, Ala.

On a development job at a southern coal mine it was found that the load was too great for a 7½-hp. slipring motor used on the hoist in a certain section. It was therefore decided to purchase another motor of 20 hp., a capacity considered ample for future loads. When the new motor was fitted to the engine and tried out it was found that it would not pull the load. The line, 220-volt, three-phase, strung along the rib, was over 2,000 ft. long, and of No. 4 stranded wire. The transformers supply-



Solid lines indicate original connection of single delta. Dotted lines show changes necessary. The jumpers marked "cut" are removed entirely. A few feet of wire and about 2 hours time were required to make the change.

ing the load were already heavily loaded. When the larger motor was on its heaviest pull, which in this case was when empty cars were being pulled up to loading chutes, the line voltage would drop to about 120, practically one-half voltage. The current would begin at about 70 amp. and would increase as full speed was approached until finally the voltage and amperage were both at 120. When the hardest pull was reached the motor would slow down until it would pull out of step and stall.

The purchase of new transformers or heavier wire was out of the question, because time was limited, and the management was striving to cut expenses. The solution applied—rewinding the motor for half voltage—worked immediately and at no extra cost.

The endbell of the motor on the connection end of the winding was removed and the connection was found to be six-pole single delta. This connection had to be paralleled to make it operate satisfactorily on half voltage. As three leads were already brought out it was only necessary to bring out three more; this was done and the wires were paralleled on the outside. The accompanying diagram shows how this was done. Needless to say this voltage change was a success—the motor now operates satisfactorily and pulls the load without a hitch.

Acid-Resistant Floor Coatings

There have recently been developed in the laboratories of the du Pont Company several concrete floor finishes that have unusual resistance to acids and various other chemicals. The base of these finishes is a non-volatile liquid that is soluble in such solvents as toluene, xylene, and solvent naptha, and dries out rapidly into a hard, somewhat brittle, resinous solid. In drying the material absorbs oxygen from the air, similar to a natural drying oil, although more rapidly, and simultaneously polymerizes to form a hard, inelastic resin. This resin is completely insoluble in all known solvents.

The base material has been prepared in the form of a dark blue-black paint; a tan coating, of the same nature; another tan coating with slightly better acid resistance, but lower resistance to alkalis; a clear solution, or lacquer finish.

These four products may be applied directly to concrete surfaces by brushing. Spraying is not recommended. At normal room temperatures an interval of two to four hours should elapse between coats. Thorough drying requires 12 to 24 hours, depending on atmospheric conditions.

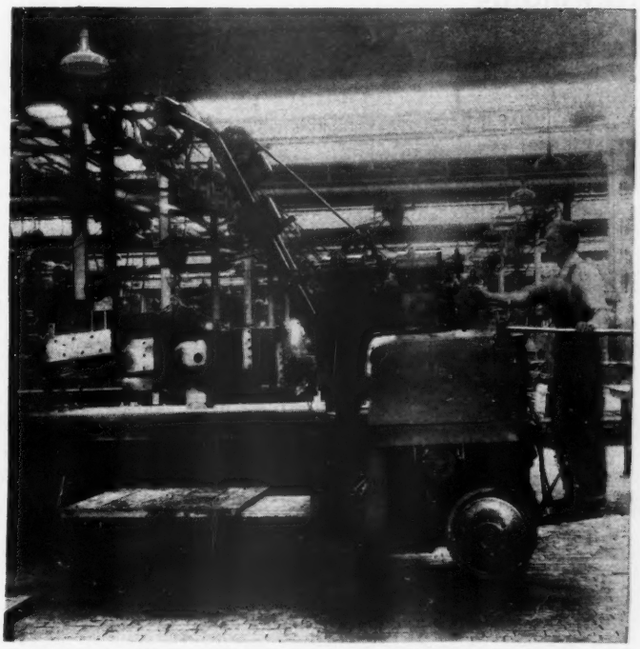
It is said that these finishes are impervious to such chemicals as sodium sulphide; sulphur chloride; bromine; chlorine; cold sulphuric acid, up to 45 per cent; dilute hydrochloric acid; high-sulphur crude oils; lubricating oils; calcium chloride brine; alkalis; alcohols; ether; gasoline; and so on. In addition they are highly resistant to moisture penetration, and are not affected by temperatures up to 390 deg. F. for the clear solution, and up to 450 deg. F. for the pigmented type.

There are some conditions under which these coatings do not give good service, such as contact with potassium chlorate and dilute hydrochloric acid. Here their resistance is said to be good, but they are not impervious. Hydrofluoric acid and strong hydrochloric acid (20 per cent and above) penetrate the coatings, so that they afford no protection. Oxidizing agents such as strong nitric acid, 45 per cent hot sulphuric acid, strong chromic acid, and hydrogen peroxide are detrimental and the finishes are not recommended for such contact.

These finishes are not yet on the market, but will be available some time this year. In the meantime samples may be had for application and test.

Double Purpose Crane Truck

SOURCE, Walker Vehicle Company



Two jobs are done by this combined lift and crane truck. Loaded skids weighing 3 tons are handled by the lift platform, and the crane hoists 1-ton parts from the skid platform into position on a machine tool as shown in the illustration.

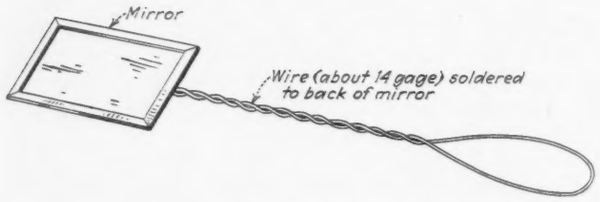
Wired Mirror for Inaccessible Places

FRANK V. FAULHABER, Brooklyn, N. Y.

Locating trouble in inaccessible parts of machines or other pieces of equipment is often a problem and the cause of much vexation. Because of this difficulty the maintenance man may be inclined to neglect the trouble. The pocket mirror shown can be used to solve such problems. It is made by soldering a piece of 14-gage wire

1 ft. long, or longer as required, to the metal back of a small mirror.

When you have made this mirror, you have a device



available that will permit suitable inspections and adjustments in hard-to-get-at places. By its aid a clear, exposed view is possible of machine parts that otherwise cannot be seen.

Rewinding Strap Wound Armatures

THOS. M. GUIER, *Universal Electric & Manufacturing Company Johnstown, Pa.*

Among the strap-wound armatures that come into our shop for rewinding was a large one used for a locomotive, with 40 coils, 5 leads per coil, and 199 commutator bars. This design means that there is one idle coil section and that the distance from the front end of each coil slot to the point where the coil leads entered the commutator varied with each coil. Because of this construction we had a lot of trouble in making the coil leads reach through the commutator on all the coils because the leads, being unmarked, became mixed.

We finally devised a scheme that remedied this trouble. This method also may be used for retaping any strap-wound armature with an idle coil section. Before stripping we marked the slot and coil ahead of the idle coil with a No. 1, the next slot and coil ahead were marked No. 2, and so on around the armature. After the coils were retaped we replaced them in the armature in numerical order, and every coil fitted into place perfectly. We did not straighten out the coil ends but tinned the ends so that there would be no trouble when soldering the commutator.

This method has decreased the total winding time on this type of armature because more time is saved in later operations than that required to mark the coils and slots.

Cheating the Scrap Pile

SOURCE, The Lincoln Electric Company

The size of a plant's scrap pile often is an indication of the efficiency of its maintenance department with respect to welding. The small scrap pile frequently gives mute testimony to the fact that arc welding is employed to full advantage. The economic advantages of arc welding in maintenance work may be classified under the heading of time as well as money. Where a worn or broken part must be replaced or repaired quickly in order to prevent loss of production, arc welding has proved to be especially advantageous, for by its use the parts can be repaired rapidly—in most cases in less time than that required to obtain a new part.

In the plant of the American Zinc Company of Illinois, East St. Louis, Ill., a single arc welding machine has effected substantial savings in repair and equipment costs. By fusing additional metal to worn locomotive tires and axles they can be built up beyond their original dimensions, and then turned to size.

Wear often denotes a job for arc welding. Shown on the right of Fig. 1 are three malleable iron elevator buckets that were discarded because of excessive wear. By welding a strip across the worn edge or lip of each bucket, as indicated in chalk in the illustration, the buckets were returned to service in good condition. New buckets would have cost $1.80, whereas $0.50 was the cost of the arc-welded repair job.

The draw ladle for a zinc furnace, shown at the left in Fig. 1, was fabricated originally by riveting, whereas ladles are now assembled by arc welding at half of the riveted cost. Chalk marks on the ladle shown indicate where arc welding is used. The large items standing on end in the background of Fig. 1 are oxide pans which, after being subjected to excessive wear, have been reinforced by arc welding and are again ready for service.

A cast-iron coal-feeder drum ready to undergo repairs by arc welding is shown in the center of Fig. 2. The chalked portion indicates the area to be built up by the fusion of additional metal. After the arc welder has applied more than enough metal the drum can be machined to its correct dimensions. The cost of such repairs to this machine part is $25, whereas the cost of a new drum would be $125. At the right in Fig. 2 is shown the back head for a centrifugal sewage pump ready to be built up by arc welding in the place chalked and then machined to its original contour.

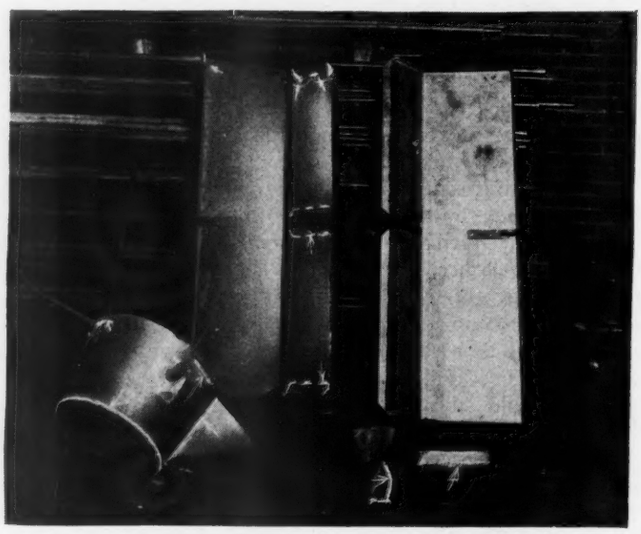


Fig. 1—Elevator buckets, a furnace ladle, and oxide pans waiting for repairs by means of arc welding. The chalk marks indicate the sections to be built up or repaired.

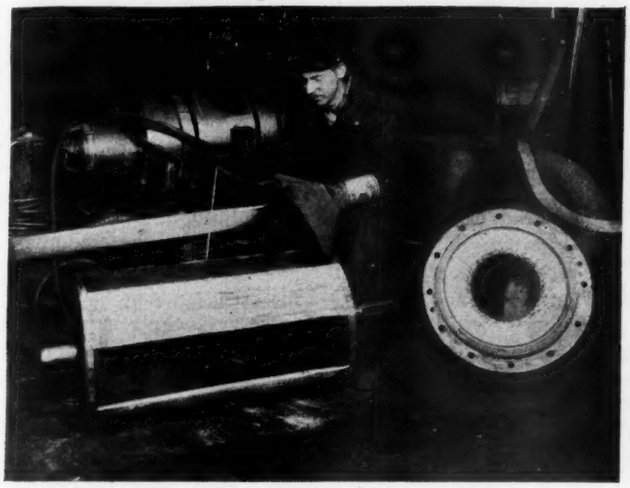


Fig. 2—After metal has been fused on the chalked areas of the feeder drum and centrifugal pump head shown, the parts can be machined to their correct size.

In many plants where arc welding is used in maintenance repair work it often has been found that the welding equipment may be utilized in the manufacture of new parts. One company made a new car body of 42-cu.ft. capacity. Car bodies of riveted construction formerly were bought from an outside source. They are now built in this company's shops by the arc welding process. By this change in construction a saving of $15 per car body is effected as compared to an all-riveted job.

Lubricant for High-Speed Bearings

CHARLES R. WHITEHOUSE, Standards Engineer
The Holtzer-Cabot Electric Company, Boston, Mass.

A good lubricant for fast-running, heavy-duty journal bearings can be made by mixing equal parts of sperm oil, cylinder oil, and common machine oil. This mixture gives excellent results under very fast running loads.

Safety Tips for Ladders

Discussion by PAUL B. SWINTON, New York, N. Y.

The article "Safety Tips for Ladders" by Mr. H. P. Leonard on page 26 of the January issue reminds me of a war-time experience. I was on the night shift of a busy munitions plant when they brought into the first-aid room one of the millwright gang with one of his toes almost entirely cut off.

He had leaned his ladder, equipped with a safety device similar to that shown, against the line shaft. To make doubly certain that the ladder would not slide, he had lifted the bottom of the ladder off the floor, intending to jab the steel points into the wooden floor blocks. He jabbed his foot instead.

To the credit of the company, the next day they started replacing the sharp prongs on the ladders with flat corrugated steel shoes about five inches long by three inches wide. One shoe was fastened to the bottom of each leg of the ladder by means of a single bolt, allowing the shoe to swivel.

Providing Efficient Loose Pulley Lubrication

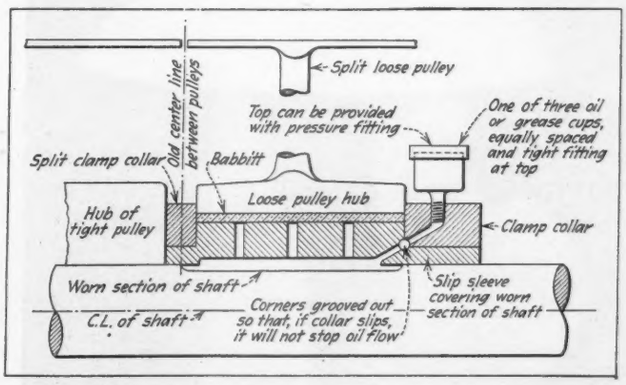
F. E. GOODING, Chicago, Ill.

The common loose pulley is often the biggest trouble maker in a power transmission line because of the difficulties encountered in lubricating it properly. In many cases the shaft becomes so worn that the pulley does not fit over it. Frequently this necessitates the insertion of a new piece of shafting.

The accompanying sketch shows how the maintenance department in one industrial plant has overcome this difficulty. A split sleeve was clamped over the worn shaft and held in place by two split clamp collars. About ½ in. or more of the hubs of both tight and loose pulleys were machined off to provide space for the split collars and to give short lengths of unworn shafting for the ends of the split sleeve to rest upon.

Steel, because of its strength, is recommended for the narrow clamp collar between the two pulleys. Cast iron may be used on the wider, outside split clamp. The outside clamp is drilled and threaded, as indicated, for three oil cups with screw tops, spaced 120 deg. apart so that, in whatever position the shaft stops, one of the oil cups is above the horizontal centerline and, therefore, will feed into the oil chamber around the shaft.

The sleeve also is provided with three sets of oil holes, spaced 120 deg. apart so that at least one of them will feed down to the revolving loose pulley. When the belt is on the tight pulley the loose pulley revolves with the


Split loose pulley
Old center line between pulleys
Top can be provided with pressure fitting
One of three oil or grease cups, equally spaced and tight fitting at top
Split clamp collar
Babbitt
Loose pulley hub
Hub of tight pulley
Clamp collar
Worn section of shaft
Slip sleeve covering worn section of shaft
C.L. of shaft
Corners grooved out so that, if collar slips, it will not stop oil flow

Worn shafts and power loss can be eliminated in loose pulleys by adapting them for better lubrication as shown.

shaft and, of course, does not require lubricant. Also, because of centrifugal force, the oil cups will not feed into the sleeve during these periods. Small grooves in the corner of the collar and the sleeve take care of any misalignment of the oil holes.

The loose pulley is bored out and babbitt lined as shown. A heavy, slow flowing oil or a light grease is used. When grease is used the tops of the cups should be provided with pressure fittings so that they can be filled with a pressure gun.

How to Remove and Replace Lamps

A. A. A. Rodriques, Maintenance Electrician, New York, N. Y.

There is a right and a wrong way to handle a fixture when removing or replacing a bulb. The uninformed maintenance man generally grasps the rim or shade of the fixture with one hand and performs the operation of taking out or putting in the bulb with the other hand. This method is wrong for often the entire socket of the fixture revolves, although not designed to do so, and the wires at the binding terminals become twisted. The result of such twisting usually is that the insulation is shelled or rubbed off enough to cause shorts or grounds. Furthermore unsightly dirt or grease spots are left on the fixture when this method is used.

The proper method of handling a fixture for bulb removal or replacement is indicated clearly in the illustration. Trouble with fixtures of the type shown occurs most frequently between the binding screws of the socket and the point where the wires leave the fixture to enter the stem.

When it is not possible to remove a burnt-out bulb by ordinary methods because it is fused to the socket or corroded, a pail or other receptacle should be placed directly under the fixture and the bulb broken into it. The remaining base of the bulb then can be removed successfully with a pair of pliers if care is taken not to damage the socket.

When screwing bulbs into ordinary sockets it is common practice to screw them in to the limit. This practice is wrong because a pressure results that exceeds the amount necessary for good contact between the base of the bulb and the center lip of the socket. When frequent bulb removal is necessary and this method is used the center lip often becomes weakened and must be pulled out.

A better method of inserting bulbs into this type of socket is to screw them in while the current is on and, as soon as they light, give them an additional half or three-quarter turn. Be careful, however, not to stop turning a bulb when it lights, or harmful arcing is likely to result.

Publications

STANDARD WOOD MOLDINGS—This revision of the 7,000 Series of molding sizes and designs in Simplified Practice Recommendation R16-29 contains eighteen pages of full size designs of standard wood molding and examples of their assembly. It suspersedes the original 7,000 Series of moldings, first published in 1925, and now included as a part of Simplified Practice Recommendation R16-29, Lumber, Fourth Edition.

The designs and their assemblies have been approved by the Central Committee on Lumber Standards. Single copies are 20 cents.

VOLUME CHANGES IN GYPSUM-FIBER CONCRETE—Gypsum fiber concrete is the term applied to a hardened conglomerate mass resulting from the setting of a mixture of calcined gypsum, wood chips, and water. It is used for roofs and floors. Although it is not directly exposed to weather in use, there is no assurance that it will always remain dry; a study has therefore been made at the Bureau of Standards of the volume changes which it undergoes in setting and those which result subsequently from variations in moisture content. Five different gypsums were used, and measurements were made on neat specimens as well as on those containing the wood chips.

The measurements of expansion during setting showed that an increase in wood chips or a decrease in amount of mixing water gave increased expansions.

Specimens which were subjected to 14 alternate soak-

ings and dryings showed a gradual increase in length from cycle to cycle. Those specimens containing high percentages (10 to 12½) of wood chips expanded much more than neat specimens.

The other specimens were subjected alternately to 10 cycles of air of high and low humidity. These specimens contracted slightly from cycle to cycle. However, the magnitude of the changes was much less than that caused by soaking.

The measurement of thermal expansion made with specimens of one calcined gypsum showed that the coefficient of thermal expansion per degree C. (27 deg. to 47 deg. C.) ranged from an average maximum of 16×10^{-6} for neat specimens to an average minimum of 13×10^{-6} for specimens containing 12½ per cent of wood chips.

ACCIDENT PREVENTION IN WELDING—In an effort to reduce the number of accidents in the petroleum industry caused by lack of adequate precautions and information concerning gas and electric welding, cutting, and burning, as well as the use of open fires in mechanical operations, the American Petroleum Institute has published "Accident Prevention Manual on Gas and Electric Cutting and Welding." It represents the work of the Institute's division of refining committee on accident prevention in refineries and cooperating representatives of companies throughout the industry.

The manual covers health and accident hazards, discusses the problem of training new workmen and overcoming carelessness in others, and takes up in turn gas welding, electric welding, and their application to the various tasks of the petroleum industry.

Copies may be obtained from institute headquarters, 250 Park Ave., New York, N. Y., or the institute's Department of Accident Prevention, 1508 Kirby Bldg., Dallas, Tex. The price is 25 cents.

Shock Absorber Eliminates Drum Distortion

WILLIAM HOLD, *Maintenance Foreman*
National Lockwasher Company, Newark, N. J.

A line of gravity roller conveyor is used in our plant to carry 450-lb. drums of metal parts between the cutting and hardening operations. At the end of this line there originally was installed a rigid stop consisting of a steel angle bolted in place. The drums used to strike this stop with such force that they became flattened on the surface that hit the stop. This distortion often made it impossible to fit the trunnions of the drums in position to empty into the hardening barrels.

To obviate this trouble I devised the shock absorber shown in the illustration. A 1½x1½-in. angle, forged in an arc of a radius the same as the drums, is free to act against the springs as shown. The springs are of ⅛-in. wire coiled loosely around ⅝-in. bolts, 5 in. long.

The bolts are connected rigidly to two 3x3-in. angle clips which are riveted to the guard rails of the conveyor. Most of the shock is taken up in the springs, and distortion has been eliminated.

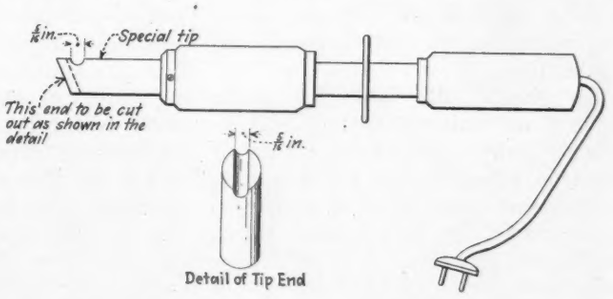
Tip for Soldering Wire Joints

R. W. SCHUSTER, Carbondale, Pa.

Shown is a special tip for an electric soldering iron designed especially to facilitate the soldering of wire joints. Because it is concave it heats the joints quicker and more uniformly than will a straight or pointed tip.

To use, put the wires in one of the concave sections and hold the solder on top of them. The solder will run down through the joint and the excess will collect on the concave surface. In this way a good job of soldering on both the top and bottom of the joint is assured.

In making up the tip cut the end on a bias as shown, so that the operator's hands will be at one side of the tip instead of directly under it when it is in use, thus protecting the hands from being burned by the overflow of solder. By cutting a concave section in both the end and side of the tip, easy access to joints is obtained, regardless of their position.

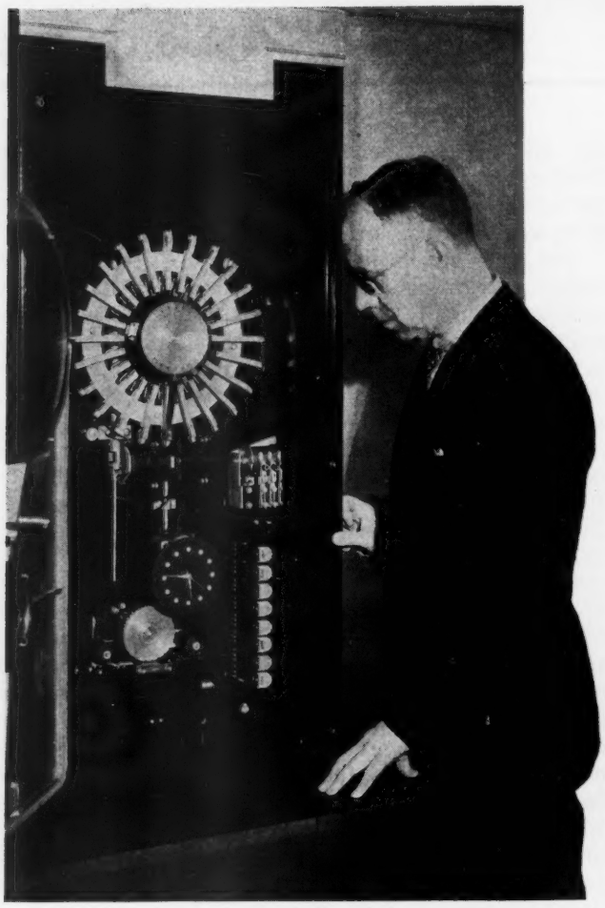


Electrical Control As It Will Be

A Look Into the Future

H. D. JAMES

Consulting Control Engineer
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.



Control for the vertical automobile-parking machine illustrates some of the points discussed in this article. The cars are driven onto cradles or parking spaces suspended from a vertical endless chain. When the driver leaves the parking machine he pulls a lever and a ticket is delivered showing the time of parking and the location of the car. At the same time the doors of the machine close automatically and the next vacant parking space is dispatched to the driveway level. The automatic dispatcher is shown above.

A FORECAST of future developments in any field obviously can be only an opinion based on judgment and a knowledge of the subject. It is not unusual for design engineers to think five or six years in advance of the commercial devices. The history of patent disclosures is a definite indication of this practice, which is essential for any growing business. New equipment must first be planned and then developed experimentally. After the engineering problems have been solved it is necessary to design a line of apparatus and build test models before the tools are made. This procedure may require several years, depending on the magnitude of the undertaking.

In viewing the future of motor control we realize that it will be influenced by the development of electron tubes, automatic telephones, supervisory power control, and radio equipment. The earliest control used a rheostat to reduce the line voltage when power was applied to the motor terminals. The decrease in voltage represents wasted power that is converted by the resistor into heat. This method of control, however, will continue to be used extensively, particularly for small motors, because of its simplicity and low cost. Where a.c. power is available the voltage can, of course, be reduced by using a transformer.

The most satisfactory method of speed control where smooth operation is important makes use of an individual motor-generator set which supplies a variable voltage to the working motor by field control of the generator.

Magnet contactors have replaced manual control for the switching of motor circuits in many applications, particularly where the service is severe or the power circuits are large. The use of contactors has made it possible to locate the control close to the motor and remote from the operating station or master switch. Automatic features such as acceleration, overload and low-voltage protection, and so on, have been added. Where the application requires it, automatic sequences of operation can be provided to cause the motor to operate through a predetermined cycle. Sometimes a single control will operate several motors, causing them to function in the desired manner.

Present practice uses the normal power supply for all control circuits, so that these must have the same insulation as the main circuits, and the secondary contacts are subject to burning when switching these circuits. The control circuits operate relays which are usually small-sized contactors with substantial operating coils. Contactors and relays are mounted on insulated bases, following general switchboard practice. The energy consumed by them usually requires inclosing cabinets to be ventilated. which exposes the control parts to dust and corrosive gases that may be present in the atmosphere.

This description of present-day motor control is given for the purpose of emphasizing certain features that

may be improved in the future. The development has been logical and the best controller practice today has resulted in sturdy and reliable equipment that performs many complicated operations and requires comparatively little maintenance. Inspection of the control equipment for automatic elevators, printing presses, sectional paper machine drive, and many steel mill applications will indicate the extent of this development and the high degree of operation efficiency rendered by the latest designs of control.

While this development in industrial control has been taking place important advances have been made in other equipment. For example, the automatic telephone, which is a complicated mechanism and makes use of many small contact devices, at first seemed impractical for large-scale operation, but its success has been very convincing and most of us now prefer it to the old system.

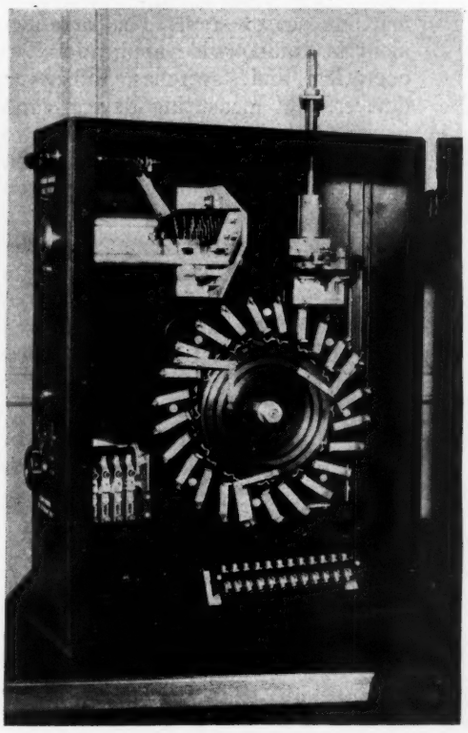
Supervisory control for substations, burglar alarm, and fire alarm systems makes use of apparatus of similar nature. The engineers in these fields have developed a technique and practice that is very interesting and has many features that should be considered carefully by motor control engineers. These systems are operated at a low voltage and require very small amounts of current. In many cases the voltage is too low to maintain an arc at the contacts and the amperage is not sufficient to cause perceptible burning. The low wattage of this apparatus permits it to be inclosed in dust-tight cases, as is done with meters and instruments that exclude the dirt and corrosive gas in the air. The contacts can be arranged in pairs so that a small particle of dust will not cause a failure.

The wiring is less expensive and more compact than power circuit wiring and the cost of installation is very much less. Due to the low voltage and small currents handled no trouble should develop in these cables if they are protected from mechanical injury.

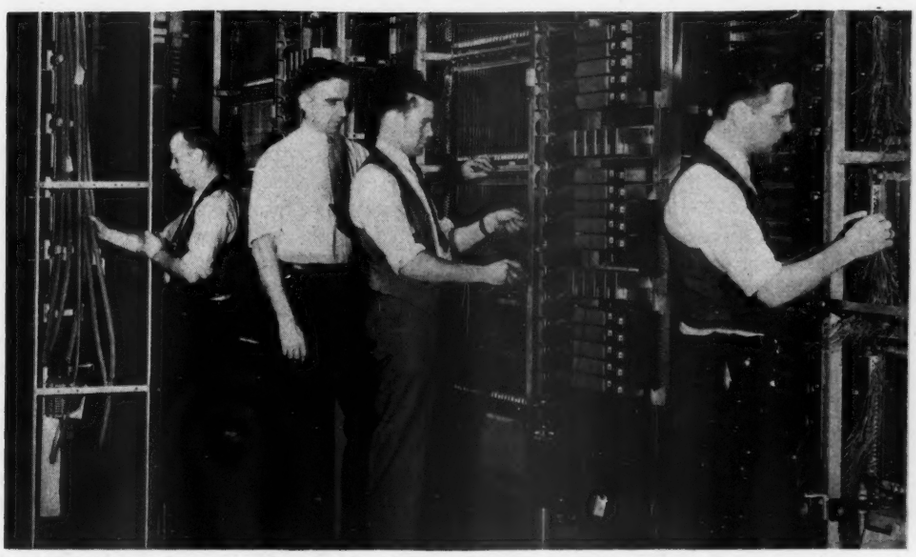
With these systems many novel and interesting schemes have been developed for obtaining different sequences of operation and for reducing the number of wires between stations. Some of these schemes are new to motor control and have found little or no application in this field.

The radio stimulated development in vacuum or electron tubes and the work has now been carried much beyond this field. Tubes are available that respond to a difference in sound, light, color, frequency, and so on. Some of these tubes will rectify alternating current. The current that flows through the tube can be controlled by means of the grid, which requires only a minute amount of energy to cause it to function in different ways. Tubes can be connected to give a delayed time response, and in combination with condensers they can be made to follow a definite time cycle. In many cases tubes give a visual indication of their operation or failure. Deterioration is gradual.

The public has become accustomed to using tubes in radio sets and there are no general objections to using them elsewhere. The power delivered by tubes may be controlled by means of condensers, inductors, a change in

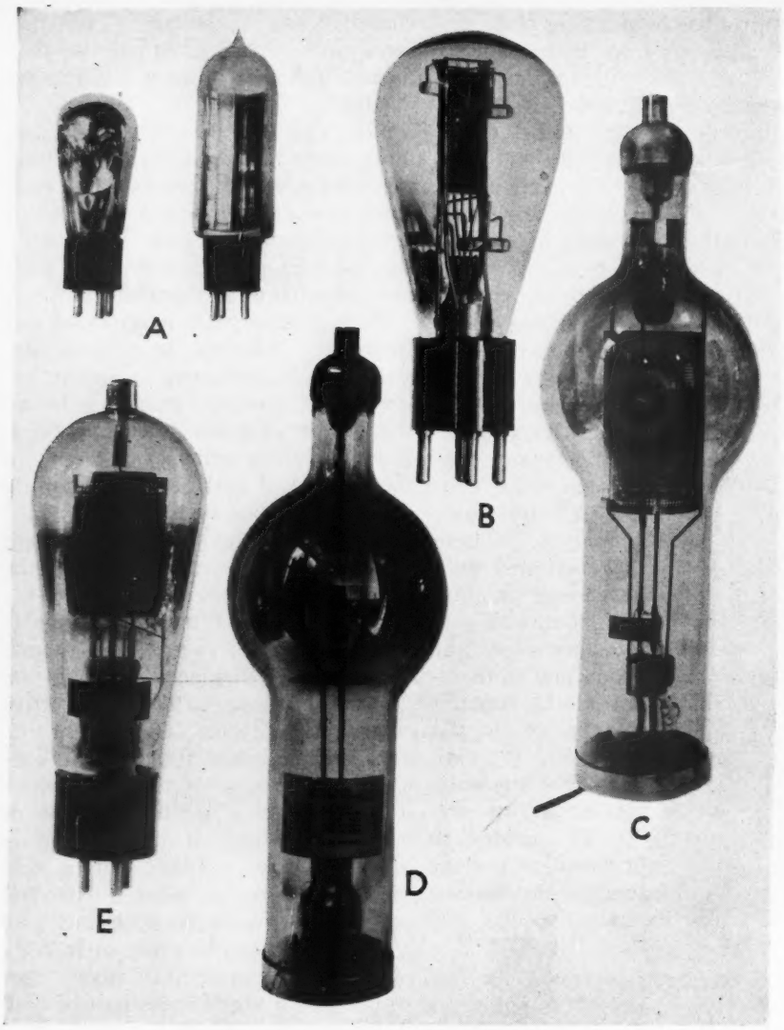


Compact, low-voltage equipment that is well protected from dust, and ingenious wiring schemes enable telephone engineers to put a large amount of equipment within a small space.



When calling for a car in the parking machine the driver inserts a key in a special lock (not shown here) which will accommodate 24 different keys—one for each of the 24 parking spaces. As the key is turned sidewise in the lock the proper cradle is dispatched to the driveway level through the medium of the rotating member in the control box shown here. When the cradle reaches the driveway the doors of the machine open automatically. To remove the key the driver must turn it to the vertical position, which causes the doors to close automatically. The complete cycle of operation is accomplished without the use of relays.

Courtesy Western Electric Company, Inc.



Electron tubes will play an increasingly important part in electrical control equipment. At *A* are shown industrial-type photo-electric tubes; *B*, a typical amplifier; *C*, a 40-amp. grid glow tube; *D*, a gaseous discharge rectifier; *E*, a grid-controlled gaseous tube.

voltage, by means of light and heat, by sound, by a variation in frequency, and in other ways.

Tubes provide a practical means of tying low-energy circuits to power circuits. A tube may control a motor directly by varying the voltage applied to the motor, or it may change the field strength of the generator in a motor-generator system of control. Tubes may also be used to vary the field strength of the motor, for speed regulation.

Magnet contactors will continue to be used as a means of opening and closing power circuits to motors. The contactor coils require considerable energy, however, and tubes may be useful for controlling these coils.

Inasmuch as electron tubes can be used for speed regulation, voltage regulation, to regulate the power input, to slow down and stop or reverse motors, they will in many cases supersede mechanical devices now in common use. The use of tubes instead of mechanical devices or magnet control will depend entirely upon their relative usefulness. Tubes will not be used where the present device performs in a satisfactory way unless they are less expensive, more reliable, or have some other distinct advantage. However, as the cost of tubes decreases and more experience is gained in their use, their application will broaden.

There are certain functions that can be performed by a tube much better than by a mechanical device; for example, a light ray can cause a tube to function, or a variable condenser can control the grid circuit without mechanical friction. The elimination of this friction may be a distinct advantage.

It is too early to speak with certainty regarding the exact field of application of tubes in motor control, but the work done so far indicates that they will be an important factor. At first the tendency will be to make some applications that are not suitable, but this tendency will assist in widening the application of tubes and always occurs when a new device has been made available.

The synchronous tie has given us a very useful means of operating two devices in synchronism without mechanical connections. This device consists of two synchronous machines tied together electrically. When one machine is rotated the other machine will turn in synchronism provided the load is not great enough to pull the machine out of step. This arrangement is finding wide application for operating limit switches, indicating devices, and measuring devices, and in large sizes is used to keep two mechanical drives in synchronism, such as the two ends of a long ore bridge or lift bridge.

A potentiometer using tube elements instead of a galvanometer can also be used for remote indication. Devices of this kind have removed many of the limitations to automatic control and are providing means for extending its field of usefulness.

The discovery and development of the de-ion principle for rupturing power circuits has enabled engineers to improve materially the performance of magnet contactors. Contactors are now available that will rupture very heavy loads at short intervals with little deterioration. This step forward has materially decreased the cost of maintenance and improved their reliability.

Automatic controller practice may be assumed to have started about 1895. The problem confronting engineers at that time was the development of suitable apparatus and the devising of systems of automatic control. At the present time the design of apparatus is well understood and it has become very reliable in performance. Many systems of control have been tried out and are well known, so that an experienced engineer has a wide variety of devices and systems from which to choose. New devices have now come to his assistance, in the form of vacuum tubes and equipment developed for telephones, supervisory control, signal systems, and so on.

In the future we may expect that control engineering will be grouped under two general heads: (1) The switching and control of the main

power circuit. (2) The supervisory or system control that causes the main switching to take place.

Under the head of "Main Switching" the principal changes in the near future will probably be the use of power tubes to give voltage control in some applications, instead of rheostatic controllers or motor-generator sets. These tubes will rectify the current so that the advantages of a direct-current motor operated from an alternating-current supply circuit will be obtained. This same advantage is now obtained by an individual motor-generator set, but there are many applications where the use of such equipment is not justified.

The greatest change will probably be made in the supervisory or system control field. The use of 25- to 50-volt control circuits carrying two or three hundredths of an ampere will result in small and compact devices, owing to the reduction in insulation distances and the elimination of arcing and heating. This part of the control can be made self-contained and inclosed in dust-tight boxes that will protect it from dirt and corrosive fumes. It is probable that the control will be built in small sections and assembled like a bookcase.

Each section will perform a particular function, such as acceleration, protection, automatic stopping, and cycle repeating. When trouble occurs with one of these functions the defective unit will be removed and a new one substituted. The controller will thus become an assembly of several units that can be replaced readily, and delays will be reduced to a minimum. The defective unit can be taken to the shop for repair.

Each unit will be completely assembled and tested by the manufacturer and sealed up before shipment in the same way that kilowatt-hour meters are assembled. All connections will be soldered, both inside and outside of the case.

The power for operating this control system will be supplied from a small-capacity unit such as a transformer, a rectifier, or the exciter of a motor-generator set. Such a source of supply will limit any possible damage due to defective circuits. The bell-ringing transformer used in residences is a good example; the secondary of this transformer can deliver so little power that there is no risk of fire or other hazards.

The wiring between this control, its master switches, limit switches, main control, and so on, will be small, multiple-conductor cables requiring only mechanical protection. The installation of these cables will follow existing telephone and signal practices. In this way installation and maintenance expenses will be materially reduced. The control will occupy little space and have little weight. The present complicated appearance of switchboards will be avoided. On account of the compactness of the control it will be combined with other machinery to make self-contained units. Noise, arcing, and flashing will be eliminated except for the main contactors.

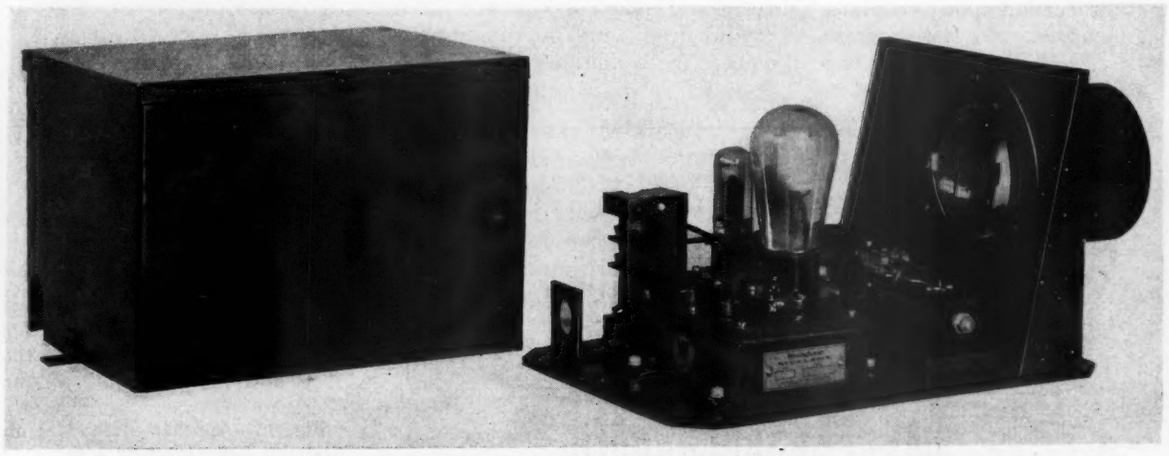
Schemes of connections will be devised so that only a small number of wires will be required between the controller and the master switch. The master switch will be small, light in weight, and in many cases will be of the miniature type similar to radio dials. Instruments and signal lights of similar proportions will be used.

All of these developments will broaden and extend the field of automatic control. Automatic recorders will be used extensively to check operations and provide production records. These records will show the load on the equipment in relation to time, and serve as a check on the efficient use of machinery.

It is probable that the supervisory control units can be made the same size for all motors, giving the advantages of quantity manufacture and interchangeability for maintenance. The main switching units only will be changed for different sizes of motors and different line characteristics. It is probable that a greater use will be made of indicating instruments to show the performance of apparatus and serve to warn of breakdowns.

Other and as yet unannounced inventions and developments will have their influence on future control design. At present the control engineer has available many new devices, methods, and systems that have not yet been assimilated, and this discussion has been a forecast of how some of these facilities may be used to make better motor control.

The design of motor control is verging on the switchboard field and the supply field. In the near future we may see a very considerable interchange of equipment and methods between these various fields, for application not only in industry, but in central stations, public buildings, and private residences.



Light beams can be made to control many different kinds of equipment by means of an outfit like this. In operation light is focussed by the lens on the photoelectric cell at the left, initiating a discharge in the grid glow tube which in turn will pass enough current to operate the delicate relay immediately below the lens. This relay is capable of controlling other devices that can handle currents of almost any magnitude. The cover has been removed from the unit shown here, which illustrates equipment employed in light control, counting objects, and so on.

LUBRICATING SYSTEMS

Filtering Devices

Twelfth article of a series. The next will appear in an early issue

FRED H. LOW
Mechanical Engineer

WHERE an excess of oil is employed, as with the bath type of lubricator, or recirculating system, it is necessary to change the oil occasionally or to provide some means of cleaning it. One of the simplest methods of cleaning the oil is by the settling process. At some point in the system a rest tank is provided, usually at a location where the motion of the oil is relatively slow. The retarded motion of the oil permits the heavy particles carried in suspension to settle out.

Oftentimes a screen strainer is used separately or in conjunction with other methods. The strainer may be a single unit, similar to the type used on automobile engines, or it may be a duplex unit such as is used on larger systems.

Cloth strainers or filters, as they are sometimes called, are used extensively on large, stationary, recirculating systems. The cloth, because of its fibrous nature, is a better straining medium than is a metal screen.

One thing necessary in these strainers is large area of the filter media. This large area is obtained in a small, compact unit, for automotive engines, small stationary engines, and machine systems, by winding cloth over two helical coils of different diameters giving the appearance of a screw of deep root.

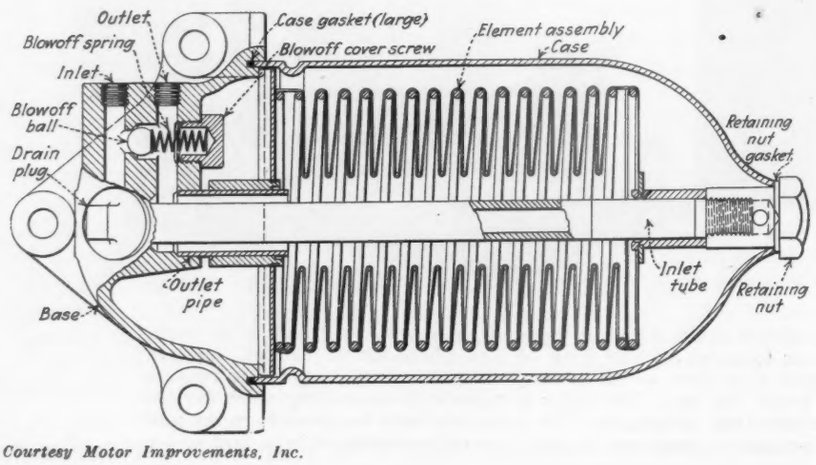
The drawing shown in Fig. 75 is a cross section of one of these strainers. The inlet opens into a hollow post extending up through the filtering element. A hole in the post, above the element, permits the dirty oil to enter the case so that the unfiltered oil surrounds the filter element. The oil is forced through the cloth into the element, leaving its deposit of dirt on the outside surface. The clean, filtered oil inside the element flows out through the outlet and is returned to the system.

The deposit of dirt upon the element surface acts as an additional filter bed, increasing the effectiveness of the filtration as the thickness of the filter bed increases. As the deposit of dirt increases in thickness, the resistance to the flow of oil increases. It is, therefore, advisable to wash the element in gasoline or kerosene about every hundred hours, depending upon the operating conditions.

A relief valve, incorporated in the base, serves the dual purpose of protecting the instrument against excessive pressures and providing an uninterrupted flow of oil in the event that, through neglect for a long period of time, the filter should become clogged.

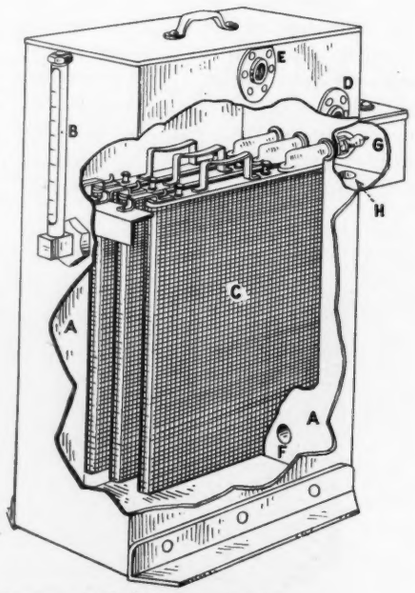
Another method of obtaining large area is to stretch the cloth in the form of thin bags over frames which hold them in shape and provide a space from which the clean oil may be withdrawn.

Putting a series of strainers of this type in a case, as shown in Fig. 76, provides a filter of any desired capacity. The dirty oil is introduced into the chamber *A*, through the opening *E*, where foreign matter and water are removed, should any be



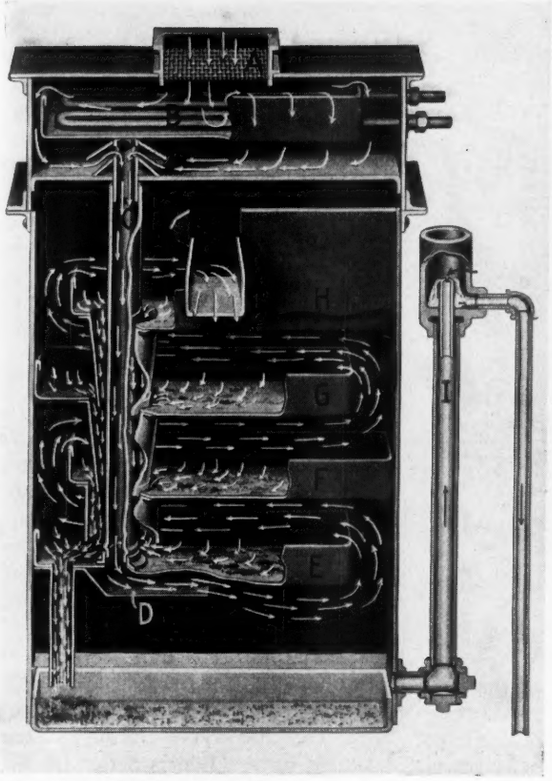
Courtesy Motor Improvements, Inc.

Fig. 75—Outline drawing of a small compact oil filter of large area.



Courtesy S. F. Bowser & Company

Fig. 76—Another method of obtaining large filtering area.



Courtesy S. F. Bowser & Company

Fig. 77—Section view of device for filtering oil without the aid of water. Because of the absence of water the method is termed dry filtration.

present. Gradually the oil seeps through the bags leaving the dirt on the outside surface. From the inside of the bags the oil flows through a special fitting into the clean oil chamber.

Because the surfaces of the bags are in a vertical position, there is a tendency for the dirt collected by them to fall off and settle to the bottom, thus extending the time the bag may remain in operation between cleanings.

A handle on each unit provides a means of lifting it out while a self closing valve prevents the passage of dirty oil into the clean oil chamber through the opening of the unit which is removed. By changing the units one at a time the filter may remain in operation during this process. Water and some of the sediment is drawn off through the opening *F* near the bottom of the tank.

Straining the oil removes only the solid matter large enough to be caught in the screen. Water, fine carbon, sludge, etc., require additional processes to remove them. The method used will depend upon the degree of refinement required. The rest tank will permit a considerable quantity of these impurities to separate if the oil is allowed to remain still for sufficient time. This settling action can be accelerated by warming the oil.

Where it is necessary to remove the foreign matter in a short time, as is the case in a continuous system, some means of decreasing the rate of flow and preventing the oil from short circuiting must be provided. The equipment developed by one manufacturer is shown in Fig. 77. Because the oil does not pass through water in the process this method is sometimes termed dry filtration.

Dirty oil is put into the tank through the screen *A*, which removes bulk foreign matter. The oil then flows over the steam coils *B* where it is heated to accelerate precipitation. From the coils the oil flows through the tube *C* to a point near the bottom of the tank where it is prevented from disturbing the sediment by the baffle *D*. It then moves slowly upward over the zigzag path caused by the baffle trays, depositing foreign matter while in transit. When it arrives at the top, all of the water, most of the entrapped air, and a large part of the dirt have been removed. The oil passes off either to the circulating system or, more often, to the filtering system already described.

The water, which accumulates in the bottom of the tank, passes out through the pipe shown to the right and discharges into the sewer. The operation is entirely automatic, the only attention required being for cleaning. To complete the cleaning process the oil should pass through filter bags. The installation can be made as two separate units or the devices can be combined into one unit.

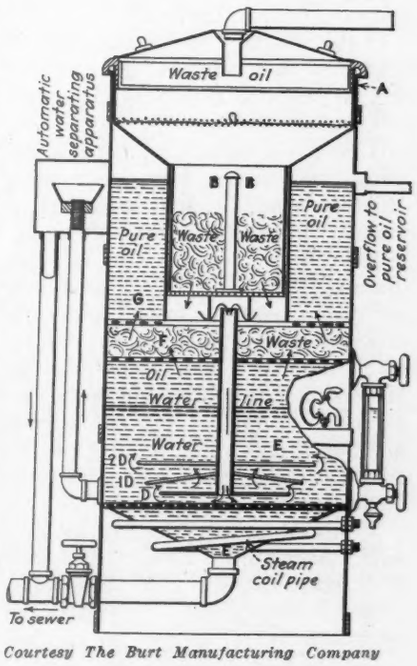
Where round units are preferred they can be supplied. The action is practically the same, except that the filter bag is on the outside of a cylinder and the oil flows from the inside to the outside. The round or cylindrical filter and settling tanks may be combined in a single unit and the filter may be made to operate during the cleaning process by the installation of two or more filter bags.

In some cases, where the oil is extremely dirty or where the process must be speeded up, a settling tank of large capacity is installed ahead of the precipitating unit. This tank is equipped with steam coils and the oil is drawn off through a float-type suction so that the top oil, which is the cleanest, is always used.

Sometimes oil is cleaned in batches. Where the oil can remain in a settling tank for a long period, the precipitating unit is unnecessary; the oil passes directly from the settling tank to the filter unit.

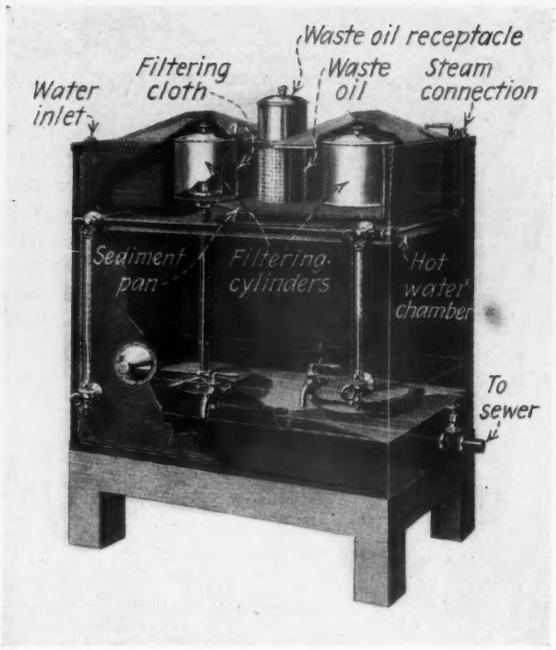
A different adaptation of the settling and filtering process is shown in Fig. 78. The oil is washed, so to speak, in water. The waste oil enters the top chamber *A*, from which it passes through a course strainer into the chamber *B*. The bottom of this chamber is filled with a thick bed of waste, through which the oil is filtered into the pipe *C*. This pipe extends to a point near the bottom of a compartment which is about two-thirds filled with water. Heat is applied by means of steam coils.

As the oil leaves the end of the pipe it is spread out into a very thin film by the horizontal disk *D*. From the edge of this first disk the oil rises to second disk by which it is gathered toward the center where it passes



Courtesy The Burt Manufacturing Company

Fig. 78—Equipment used to wash and filter oil.



Courtesy The Burt Manufacturing Company

Fig. 79—A device in which filtering precedes washing. Bone-black is used as a filtering medium.

through a series of holes up to the third disk and is again spread out into a thin film. This process exposes all parts of the oil to the cleansing action of the water.

From the outer edge of the last disk the oil rises to the top of the compartment, the upper third of which is occupied by the washed oil. Gradually this oil is forced up through the layer of waste into the clean oil chamber *G*, from which it is drawn to the pure-oil reservoir of the circulating system. The surplus water rises in the pipe, shown to the left, and flows into the sewer.

In the unit shown in Fig. 79 the order of filtering and washing is reversed. The dirty oil first enters the waste oil receptacle and passes through the small perforations, flowing in a horizontal direction, in a pan heated by hot water, to the two filtering cylinders. In passing to these two cylinders the heavy impurities fall by gravity into the sediment pan and do not clog the filtering cloths or material. Each cylinder is wrapped with a cloth through which the oil must pass before entering the filtering cylinder.

In the cylinder is a quantity of animal bone-black through which the oil passes. It then flows down the tubes to the bottom of the filter. There it passes through the water under the disks, as described, and any impurities remaining drop to the bottom of the filter. Sludge and other matter can be flushed out at any time simply by opening the gate valve.

Where floor space is a factor or where strict economy is necessary the filter itself may be used as the gravity tank for the recirculating system. Usually, however, it is better to clean the oil before pumping it, thus reducing the wear on that member.

Repair Shop Procedure

(Continued from page 148)

are also tested at 2,300 volts for shorts, opens, and grounds.

If the tests are satisfactory the reconnected motor is placed in one of the two electric ovens and baked at 220 deg. F. for three or four hours, to free the windings from moisture. After they have been thoroughly dried the motor is immersed in baking varnish until the coils have been completely impregnated. It is then drained, and again baked, this time for twelve hours. On all motors this procedure is repeated four times—four dippings and four bakings. Motors intended for severe service are given an additional coat of varnish and baked once more. After the last coat has been baked on, all surplus varnish is removed.

From the baking oven the motor is again taken to the storage bay, where it is reassembled. The reassembled motor is then given a thorough running test and all repairs are checked.

All rewound motors are given a coat of paint before they leave the shop, and, if requested, they are painted to correspond to the customer's own color scheme.

Leads are measured when the motor is dismantled and new leads are made one inch longer to facilitate reconnection. Nameplates are removed and cleaned. Oil well and overflow covers and caps are repaired if damaged and replaced if missing. Bearing housing covers are also repaired or replaced. These and other services are performed without charge.

After each repair operation is completed a note of the elapsed time is sent to the superintendent's desk for his approval and then to the office where it is transferred to the cost sheet, (Fig. 6).

In addition to our regular repair business we also repair small motor-driven tools, oil burner, and refrigerator motors, and maintain a repair department for this class of work. The small-motor department occupies a space adjacent to the receiving bench and is completly equipped with parts, materials, and the necessary machine tools for mechanical repairs.

Motor receiving and recording procedure is much the same as for the larger units. The bookkeeping, however, has been simplified. Motor data, parts and materials used, and the time and labor charges are all recorded on the combination job and cost sheet illustrated as Fig. 7. This form is a summary of the workmen's time cards and the shop requisitions.

Cleanliness is one thing we insist upon at all times. We feel that a clean shop makes for higher efficiency, better work, and improved morale. One man is employed whose sole job it is to keep things clean and in order.

Attached to each machine in the shop is a brass tag bearing the number under which it is listed in the inventory. Any repairs made to a machine are charged against that number. All motors driving shop equipment are inspected and oiled weekly. Once a year every motor is taken apart, cleaned, and checked for wear.

Loose leaf binders on the superintendent's desk, near the receiving bench, contain copies of the work and cost sheets for every job in the shop. It is thus possible for him to determine the status of any specific repair job in very few minutes. An interdepartment telephone system facilitates followups.

A Two-Inch Power Plant

This light-sensitive device will operate relays without external voltage

Fig. 1—The Weston "photronic" cell, a small electronic generator capable of producing enough current to operate controls without external power.

GENERAL applications of photocells in industry are by now more or less familiar. Many accounts of light-sensitive devices controlling equipment, detecting and recording smoke, sorting products as to color, and the like have appeared in engineering and trade literature. Today the question confronting the plant engineer is no longer "Shall I use light-sensitive equipment?" but rather, "What type of such equipment is best for my particular industrial application?"

Until quite recently a serious limitation existed in the fact that all light-sensitive devices on the market required some method of amplifying the feeble currents or potentials produced—usually by means of the thermionic tube. Indeed, as late as December, 1931, a writer in *The Review of Scientific Instruments* could say that "the power sensitivity of none of the classes of light-sensitive devices with normal cathode areas (order of a few sq.in.) and with normal incident light flux (order of a few tenths of a lumen or less) is great enough to operate directly a reliable relay, requiring, say, 25 milliwatts. The selenium bridge and the gas-filled cesium-oxide tube most nearly meet the requirements, while the vacuum cesium-oxide tube and the copper oxide cell follow in order."*

Since then, however, the Weston Electrical Instrument Corporation has announced the successful completion of several years of research on a new type of cell, christened "photronic," designed to overcome this difficulty. Maintenance engineers should be greatly interested in this development, for it offers them a light-sensitive control device which does not require the accessories demanded by photocells hitherto available.

The cell (Fig. 1) is a small electronic generator, capable of producing enough current to operate controls, so that no external source of power is needed. It is of simple construction, is not evacuated, and consists merely of a metallic disc coated with a light-sensitive film. The metallic disc forms the positive terminal, and a metal collector ring in contact with the film, the negative. These terminals may be plugged into an ordinary 4-prong radio tube socket, and the unit then directly connected to an indicating meter or relay without the necessity of an exterior source of voltage, or of any amplifying device. The cell is contained in a molded bakelite case, with a window of glass or quartz according to the application.

The close association between the

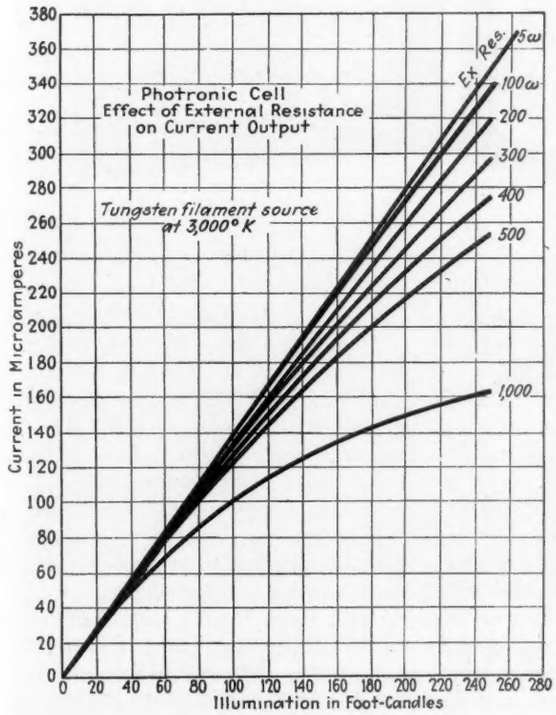

Photronic Cell
Effect of External Resistance on Current Output
Tungsten filament source at 3,000° K
Ex. Res. 75ω
100ω
200
300
400
500
1,000
Current in Microamperes
Illumination in Foot-Candles
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380

Fig. 2 — Current output increases with illumination in almost a straight-line relation for relatively small values of external resistance.

*"Optimum Outputs of Photo-Sensitive Devices" by Earl D. Wilson. *Review of Scientific Instruments*, December, 1931.

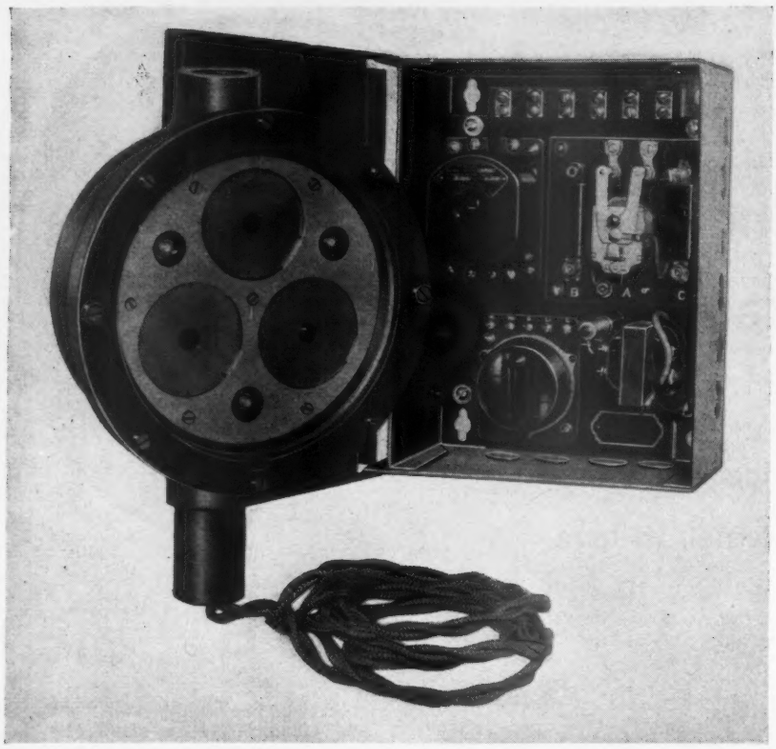


Fig. 3—Illumination control relay with light collector. The relay cabinet may be located at a considerable distance from the light collector, as dictated by the convenience of installation.

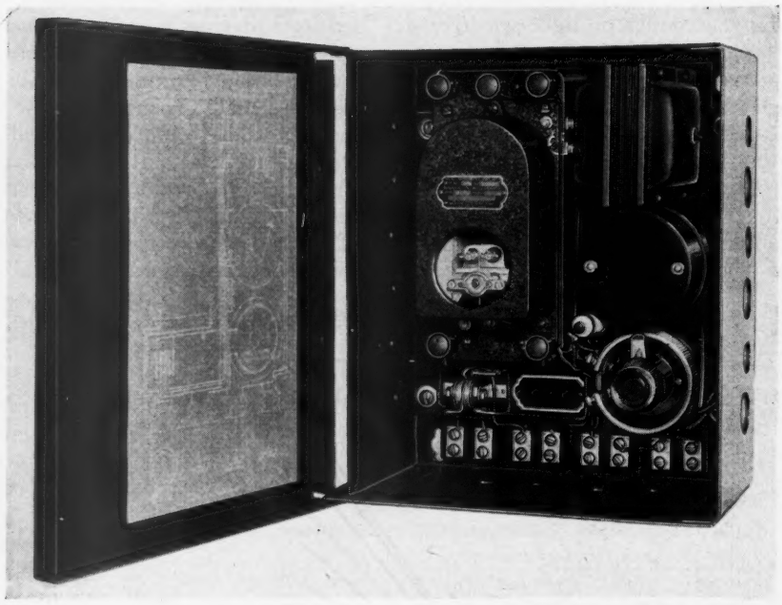


Fig. 4—Industrial control relay for counting, sorting, and general control.

light-sensitive surface and the metal plate permits the generation of considerable current without requiring any external voltage to force the current through a high internal resistance. While more sensitive relays are required with the photronic cell than with ordinary vacuum-type cells using amplifiers, the internal resistance is sufficiently low and the wattage output high enough to allow the use of available instruments and relays.

Fig. 2 shows how the current output increases with illumination. For other than relatively low external resistance the current output with change in illumination falls off as shown.

The cell may be considered as a current output device, and the external circuits should be arranged to maintain as nearly as possible the straight-line, current light-intensity relationship. This is always preferable since the current increases directly with the increase in light intensity. Wide fluctuations in temperature change the current very little.

It is claimed that the cell has no measurable deterioration. A test cell was exposed to direct sunlight all summer, and a current of 10 milliamp. drawn from it continuously, with no discernible deleterious effects. Excessive temperatures, however, are harmful, and the cell should never be exposed to a temperature higher than 120 deg. F. Care must also be exercised when the cell is exposed to a large proportion of infra-red or heat rays, because this energy absorbed by the cell may raise its temperature unduly. Radiation from tungsten filament sources consists largely of infra-red rays, and when high intensities are measured, 500 foot-candles and higher, the cell should be exposed only long enough to obtain a reading.

The sensitive relays required to operate from the cell have been available for a great many years. The output of the cell is sufficient to allow a relay of considerable torque and reliability to be used. An auxiliary relay should be employed to handle the power circuits.

Combinations of the proper sensitive and auxiliary relays are available for many purposes. Among these are relays for illumination control, counting, sorting, conveyor control, safety devices, level control for tanks and bins, and the like.

The illumination control relay with its light collector is shown in Fig. 3. The light collector consists of three cell elements in multiple which treble the current output and allow the apparatus to be adjusted for low levels of illumination if desired. The relay cabinet may be located at a considerable distance from the light collector, as dictated by the convenience of installation. This would be impossible with cells requiring amplification because of their sensitivity to variations in circuit resistance and leakage.

Maintenance engineers will not be especially interested in this cell's application to audio-frequency circuits, such as those employed in talking pictures. Experiments have shown that as at present developed it is not well adapted to this sort of work, since its response decreases in inverse pro-

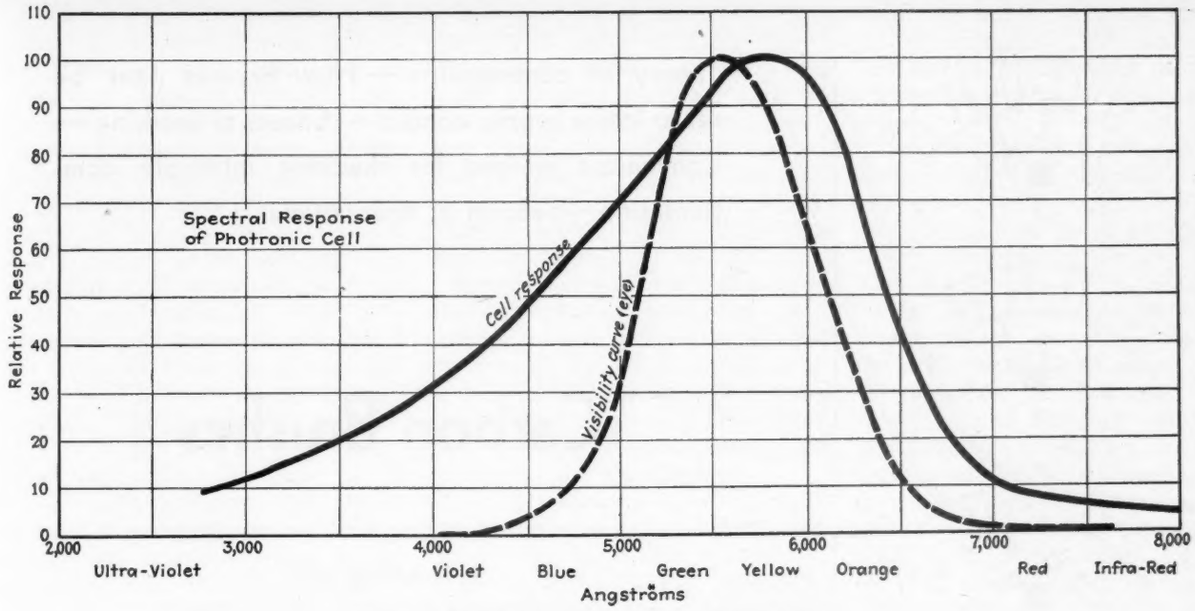


Fig. 5—Spectral response of the photronic cell.

portion to the frequency. But the cell can be used on any counting application met with in industry, limited only by the sensitivity and period of the relays available. Entirely satisfactory test results have been obtained for counting frequencies as high as 300 per minute. In fact, the cell response is so much more rapid than it is possible to make any mechanical relay that its action may be considered instantaneous for any counting requirement.

Fig. 4 shows the industrial control relay for purposes of counting, sorting, and general control. Light sources are available for almost any application. In many cases a standard lamp of 40 to 100 watts rating is all that is needed. In other cases a spot light should be used. These spot lights are more efficient if small filaments are used in the lamp. Automobile headlight bulbs are ideal for such purposes. In the industrial control relay, a source of low voltage is available for energizing these auxiliary lamps.

Spectral response of the photronic cell is shown in Fig. 5, and may be seen to correspond closely with the visibility curve of the human eye. These tests were made on cells without windows in order to obtain the ultra-violet and infra-red response in addition to the visible. With suitable light filters the cell can therefore be used in color matching work. Fig. 6 shows a circuit to be used where extreme sensitivity is required for comparison in color matching, or a sensitive circuit is desired for other purposes.

Naturally, a photo cell with such spectral characteristics is very useful for illumination intensity measurements. Fig. 7 shows an intrument for such purposes. It has a light target on the end of a flexible cord which is placed at the spot where light intensity readings are desired. These readings are obtained on the scale of an indicating instrument. No calculation is needed and readings are directly in terms of foot-candles. No batteries are in the circuit.

This illumination meter is calibrated for a tungsten filament source at a color temperature of 3,000 deg. absolute. Corrections for the readings must, of course, be made for measurements under other conditions. For such a meter approximate correction factors would be as follows: for daylight readings, the results probably would be 10 per cent low; for blue sky, 10 per cent high; for white flame carbon arc 20 per cent low.

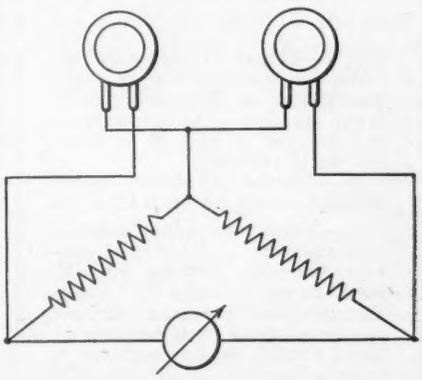


Fig. 6—Cell circuit for extreme sensitivity.

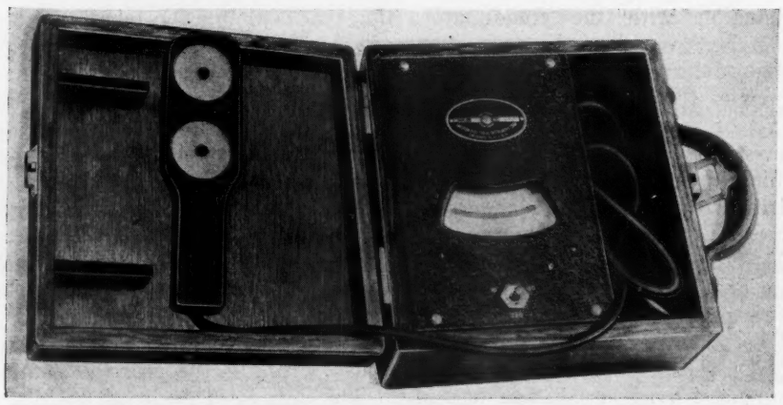


Fig. 7—Illumination meter. This type of instrument removes the "human equation" from illumination measurements, because its indicating meter reads directly in foot candles.

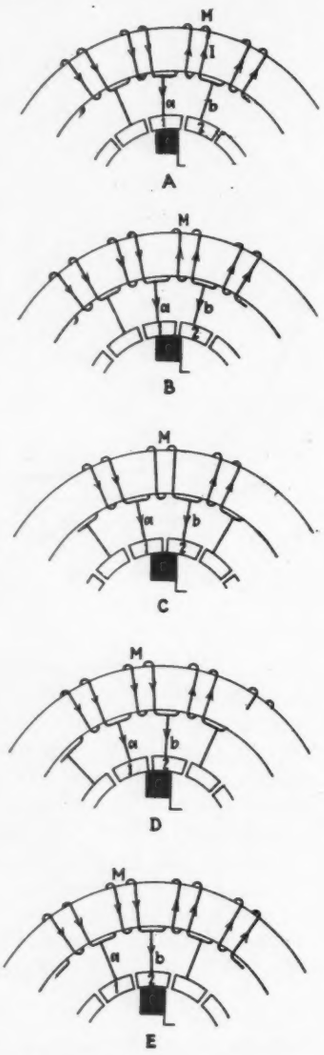


Fig. 1—Stages of commutation —As the armature moves from position *A* to *E*, brush passes from segment 1 to segment 2, and current in coil *M* is automatically reversed.

A—Current *I* enters brush through commutator lead *a*.

B—Brush now makes contact with segment 2, and part of current formerly flowing into *M* now flows directly to brush through lead *b*; some current continues through *M* because of small contact area at segment 2.

C—Contact area at segment 2 now equals that at segment 1; current in *b* equals current in *a*; current in *M* (now in "neutral") has decreased to zero.

D—As contact area at segment 1 decreases, current in *a* ("throttled" by this high resistance) decreases and current in *M* increases.

E—Current in *M* has been raised to value *I* by "slide-valve" action of high-resistance brush; contact can now be broken without sudden change of current in *M*, and therefore without sparking.

Theory of commutation — How brushes must be set to insure proper contact — Causes of sparking — Convenient method for checking interpole compensation—Second of three articles

Carbon Brushes

J. S. MARCUS
Sales Manager Electro-Nite Carbon Company
Philadelphia, Pa.

COMMUTATING properties of a brush under given conditions have a far greater influence on brush life than any single characteristic. Although, in general, a soft brush should wear faster than a hard one, hardness is not a criterion of life; friction and chatter may enter in, and the soft brush may run more quietly. Linear and angular speed, spring pressure, and refractory properties all have their effect on life in respect to mechanical breakdown. Arcing, from whatever cause, will unquestionably cause the major portion of brush wear.

Commutation

On a slipring machine a brush simply provides a suitable sliding electrical connection between the line and the rotating armature. But a brush on a d.c. commutator leads the current into and out of the armature; and, in conjunction with the commutator, causes the reversal of the connection of the armature coil to the line as the coil passes from the field of one pole to that of an opposite pole. During commutation the brush also short-circuits the coil for an interval. Fig. 1 demonstrates the stages of commutation.

With the brushes so set that during the brief time of short circuit the coil cuts no lines of force from the poles, and so generates no e.m.f., the coil is said to be in "neutral." If a low contact resistance brush, say one of metal, were used, there would occur at the instant of release from short circuit a sudden change of current in the coil, with arcing across the small air gap as a result.

Sparkless Operation

In the ordinary d.c. motor or generator the current in the coil under commutation must reverse during an infinitesimal part of a second. Actually, however, the current will not be wholly reversed at this last instant when the brush leaves the bar, as in diagram *E*, Fig. 1, because the coils, being wound on iron cores, have considerable self-inductance which creates a counter e.m.f. tending to maintain the current in its original direction. Therefore there is a considerable current circulating through the short circuit path of brush and coil. This current tends to flow after the brush has ceased contacting with the segment, and arcs back across the air gap to the brush.

It is necessary for sparkless operation that commutation take place, not on the true neutral plane midway between poles, but on a commutating plane where the coils cut sufficient field flux to have induced in them an e.m.f. opposite to their own counter e.m.f. and just equal to it. This result is obtained by shifting the brushes (forward in the direction of rotation in the case of a generator, backward in the case of a motor) so that the coil is short-circuited in a magnetic "reversing field." This brush setting is the *practical* neutral.

The shifting of the brush position is still further affected by the armature reaction, which distorts the field flux under the poles.

If the load on the machine is increased or decreased, the strength of the reversing field must also be changed to maintain sparkless commutation. In actual practice, it is customary to set the neutral at the position of average load.

Because it is impossible to shift the brushes with every change in load, auxiliary poles (interpoles) are used —exciting coils in series with the brushes, so wound on small pole pieces midway between the main poles that their polarity is the same as that of the field in which the coil is commutated. They are usually designed to carry 50 per cent overload before saturation. Their purpose is to counteract the armature reaction at the point of commutation, and to provide a slight field to overcome the reactance of the short-circuited armature coil under the brush. This reversing field intensity varies directly with load, and directly with the counter e.m.f. to be neutralized. Therefore no shifting of the brushes is required, and they can be set permanently at the neutral plane.

A simple method of checking the neutral is to make a dummy brush of wood or fiber, inserting small carbon rods through it to contact with the commutator on the center line and equidistant from center near the front and back faces. Using a low-reading volt meter (3-0-3), the drop from the two outer rods to the center one should be equal. The same equipment can be used to check the interpole compensation (Figs. 2 and 3).

The fact that brushes are off neutral is endicated by a snappy, blue-white spark, and sometimes by varying speed. The faces of the brushes themselves will show a characteristic marking.

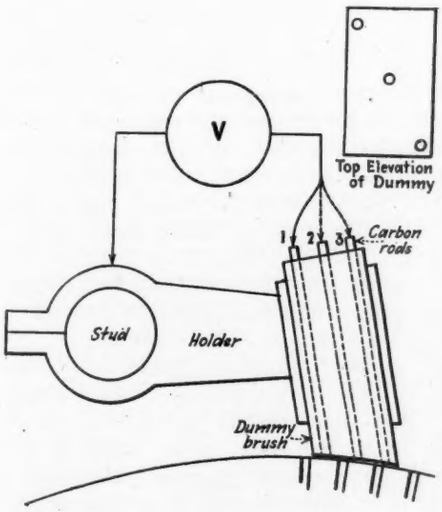


Fig. 2—Hook-up for checking interpoles. This method is used where there are several brushes in parallel. Inserting the dummy brush, and leaving remaining brushes on the rigging as they were, enables contact potential values to be found for various points along the faces of the other brushes on that rigging.

Common causes of sparking—Handling or repair work may change the angle of brushes so that at the contact face their position is incorrect. A change of grade of brushes on a very critical machine may change the neutral, because then the resistance of the circulating current path is changed, and consequently the relative values of the induced voltages.

Heavily overloaded and overheated machines sometimes develop short circuits in interpole windings, and consequently one set of brushes is out of balance and sparks. A reversed interpole coil will cause a vicious blue-white spark at one stud, and considerable sparking at the others.

Dirt is a common cause of sparking, readily distinguished by the reddish color of the spark. A film of oil or grease, and dust from the air and from brushes are conductors of such high resistance that the heat produced is sufficient to ignite particles. The degree of firing depends on the amount of dirt, and it will range from intermittent sparks along the commutator between brushes to streamers and in extreme cases to reddish ring fire. The commutator will show a smudgy black color, and a finger drawn across it will be heavily stained.

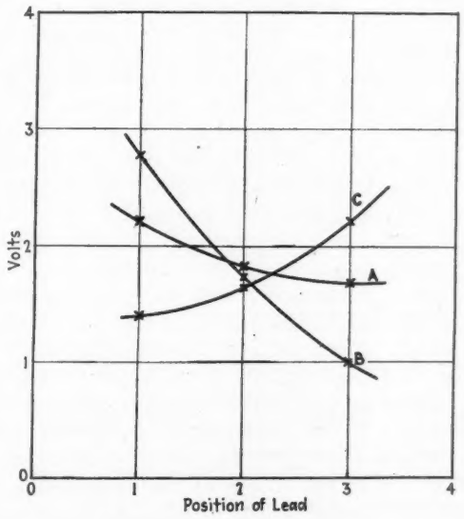


Fig. 3—If contact potential is uniform, the interpole is correctly compensated. Each interpole must be checked independently. *A*—correct compensation; *B*—over compensation; *C*—under compensation.

Reddish streamers coming from the brush tips are really burning particles of carbon, either torn from the brushes by high mica, or resulting from disintegration of the brush. This disintegration may be due to binder breakdown from long overload conditions, or to the charring of the brush tip by severe arcing.

Unless the brushes are evenly spaced around the commutator, the unbalance will cause sparking—rather more severe at the stud out of line. A simple way to check spacing is to wrap a strip of paper around the commutator, and to mark off on it the exact circumference (at the lap). This distance should then be divided into as many spaces as there are poles.

If brush holders have been tilted to a greater angle than that of their original setting, the contact area is increased over that for which the machine was designed, and therefore too many coils will be short circuited, as though the brush were too thick. Also, the tips of all the brushes on a stud must lines up with each other.

The following test for thickness can be made: Remove a brush, and at the front and back of the holder touch the commutator of the running machine with insulated leads from a low-reading volt meter (pencils with attached wires will do nicely). This gives the commutation voltage. Shift the rigging to the point of best commutation. If commutating voltage has increased, the brushes are spanning too many bars, or the neutral field is too narrow. If making the brushes thinner does not help, it may be necessary to widen the neutral field by grinding off the pole tips. (In general, brush thickness should not exceed 25 per cent of the space between pole tips, as referred to the commutator; 20 per cent is better).

Continuous overload operation, particularly on modern machines where the current density is originally high, or the use of a brush with insufficient carrying capacity, results in the peculiar action known as "picking copper." This is the formation of a

copper deposit by excessive local currents. The contact drop is lowered in time, and arcing and burning follow. The metallic copper will also groove the commutator.

Overload will cause sparking on a non-interpole machine by shifting the neutral position, and often on an interpole machine by building up the circulating currents beyond the saturation point of the interpoles. In addition, the combined currents under the brush may cause a breakdown of the material, and cumulative trouble is started. The insufficient initial contact is still further lessened by burning, and this reduction in turn increases the burning and pitting. This increase in temperature becomes considerably higher than the normal overload increase.

A variable air gap between the armature and the pole pieces will cause an unbalance in the voltages between the brush arms, and consequently eddy currents through the armature and rigging, which in turn, if sufficiently high, may cause sparking. Badly worn bearings or poorly aligned pedestals will allow the armature to drop, producing a variable air gap. Where dirt is of magnetic nature an accumulation of it on the pole face also will change the gap.

The practice of "cutting out" defective coils in the armature causes a voltage variation.

Grounds, open circuits, weak fields, and short circuits can be found only by testing, although an open or shorted coil will usually evidence itself by a particularly bad burn between the two bars to which it is connected.

The intensity of the snappy, small, blue-white spark which evidences poor contact varies with the cause. The farther the brush leaves the commutator the more vicious the spark, and the nearer this departure is to the period of short circuit, the greater the arc. The different types of burns on the commutator will by their nature often indicate the cause of poor contact, which are of clean appearance compared to burning dirt.

Contact

Even in interpole machines, a certain amount of dependence is placed on contact drop, because the induced commutating e.m.f. does not completely neutralize the reactance voltage in the coil, and is not in exact phase with it because of hysteresis and eddy current lag. Moreover, on heavy overload, the commutating field may become saturated and deficient, and the difference between the currents is brought about by contact resistance.

In tracing brush trouble, first eliminate all the possible sources of poor contact. Unless brushes are rightly fitted to the contour of the commutator (not just put into the holders, or half sanded in), the faces will make contact over just a portion of the proper area; and the current density over this smaller area will be very high, causing heat and even a burned or pitted face, still further reducing the contact area and increasing the burning, and so on to serious trouble. It follows that with greatly reduced contact area, contact drop is not normal, nor are the coils short circuited at the proper instant.

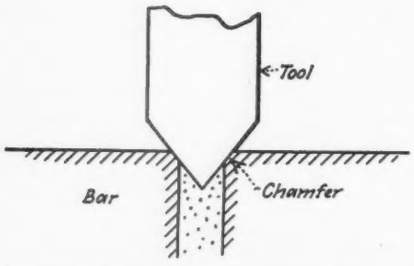


Fig. 4—The modern practice in undercutting mica is to use a *V*-shaped cutter, or special file, gaging the depth to include the chamfering of the bars.

High speeds of modern machines have led to the use of inclined brushes and to departures from radial settings, even on many types of reversing equipment. Indeed, the best angle of brush inclination to radial normal, for smooth operation with a minimum of play under variations of spring tension, is approximately 15 deg. trailing for box type holders, and 35 deg. leading for reaction type.

The condition of the brush holder itself, if of the box type, is important. If the inside of the box is not free from burns or dirt, if it does not permit free play of the brush, the brush may stick or bind, or ride above or too lightly on the commutator. When the box of the holder is badly worn or burned away or the brush is too thin, a rocking action will take place, forcing the face of the brush out of full contact. The movement of the brush in the box will draw arcs between the brush and side of the holder, wearing both away, even to destruction of the brush, and often to a point where the brush will jam in the box and ride off of the commutator.

Attempts at economy by securing brushes too long originally or by wearing them until too short usually prove futile because of increased commutator maintenance. A brush too long will not permit the tension spring to bear in a true direct line and will force the brush over in the box. A brush too short will not have sufficient bearing in the holder to prevent a chattering vibration, even when blocks are placed above the brush to keep the tension at its proper degree. It is advisable to use the spring pressure recommended by the brush manufacturer for the particular grade used, and to check this periodically. Springs that have been in service a long time lose their elasticity and acquire a permanent set, and springs that have been heated from overload or flashover lose temper in varying degrees.

High mica is the remaining source of poor contact. Normal wear, or arcing from some other cause, will gradually wear or burn away the copper face of the bars, leaving the mica projecting. These tiny bumps of mica throw the brushes from the commutator, and the arc that occurs burns away still more copper, making the action cumulative, until flat spots and deep burns necessitate turning down the commutator.

The modern electro-graphitic brush material made for carrying higher loads at higher speeds is so non-abrasive that unless extraneous cutting material is compounded into it, it will not keep the mica down. On the other hand, anything that will cut mica will cut copper, and excessive commutator wear will result. Furthermore, most of these modern materials are too soft to stand the constant mechanical pounding from high mica. Therefore the brush manufacturers have gradually taught the field to undercut the mica, leaving just a copper surface for the brush.

Unless all the projecting mica from bar to bar has been completely removed for the entire length of bar covered by brushes, little has been accomplished. Therefore it is always advantageous to chamfer the bars by runing a three-cornered file down the slot until a continuous line of copper is visible on both sides.

As a commutator ages there is a shrinkage of the mica that requires taking up. Failure to do this will result, through heat and centrifugal action, in loose, high, or low bars, chattering, or broken brushes.

Poor contact at a given point may also be occasioned by a badly eccentric, high rotative speed commutator, by a bad belt splice slapping the pulley, by a broken gear tooth, or by a dead-center pound in a driving engine.

MAINTENANCE ORDER SYSTEMS

Part IV—Analyzing the Sources of Maintenance Costs

G. I. ROSS

Chief Engineer, MacDonald Bros., Inc.
Boston, Mass.

A VARIATION in the maintenance order system is found in a manufactory of small metal parts employing 500 people.

In this case written orders are issued for all maintenance work which is estimated to entail a cost exceeding $5. Form A (Fig. 4) is made up and distributed as follows:

Original—Prepared and signed by the foreman requesting the work; approved by the Plant Engineer; approved by the Plant Manager; forwarded to the Cost Department for the assigning of an order number; filed in Cost Department for future reference.

Duplicate—Accompanies the original to the Cost Department and is then forwarded to the Master Mechanic as authorization for the performance of the necessary work.

Triplicate—Remains with the foreman making the original request. This copy need not be a printed form. A plain piece of tissue is sufficient.

Systematic methods are pursued in recording the costs. Form B (Fig. 5) is used by the Master Mechanic for this purpose and the reverse side of form A is used by the Cost Depart-

FOR COST DEPT.

MATERIAL		LABOR					
DESCRIPTION	AMOUNT	MAN NO.	AMOUNT	MAN NO.	AMOUNT	MAN NO.	AMOUNT

FORM A

REQUEST FOR SHOP ORDER

NO WORK TO BE STARTED UNTIL THIS FORM IS APPROVED

PLEASE ISSUE SHOP ORDER TO COVER THE FOLLOWING	
	DATE
	PLANT FOREMAN
	PLANT ENGINEER
	MANAGER
	CHARGE TO
	ACCOUNT NO.
	SHOP ORDER NO.

INSTRUCTIONS:- ISSUED IN DUPLICATE - BOTH COPIES TO BE APPROVED BY PLANT ENGINEER AND MANAGER. ORIGINAL TO BE FILED IN COST DEPT. DUPLICATE RET'D TO SHOP TO BE ISSUED FOR MAKING OR REPAIRING EQUIP. WHEN ESTIMATED TO COST OVER $500

Fig. 4—Form A, original and duplicate, obverse and reverse. Written orders are issued for all maintenance work exceeding $5. Actual size, 8x5⅜ inches.

ment for the accumulation of maintenance costs. A copy of the latter form is sent to the Master Mechanic's office after the job has been completed. This is used to complete the posting of form B. All maintenance costs are thus recorded, a procedure which permits the analysis of the sources of the major costs.

Next month one more small plant will be discussed before the maintenance order problems encountered in larger and more ramified organizations are considered.

In Part II of Maintenance Order Systems appearing in the January issue of MAINTENANCE ENGINEERING the last sentence of the second paragraph should read "The material which is needed for the performance of the work is then withdrawn from stores on a material requisition and charged to the expense account involved."

The author wishes the last sentence of the last paragraph on the same page to be corrected to read "Material charges are allocated with the same care that labor charges are allocated."

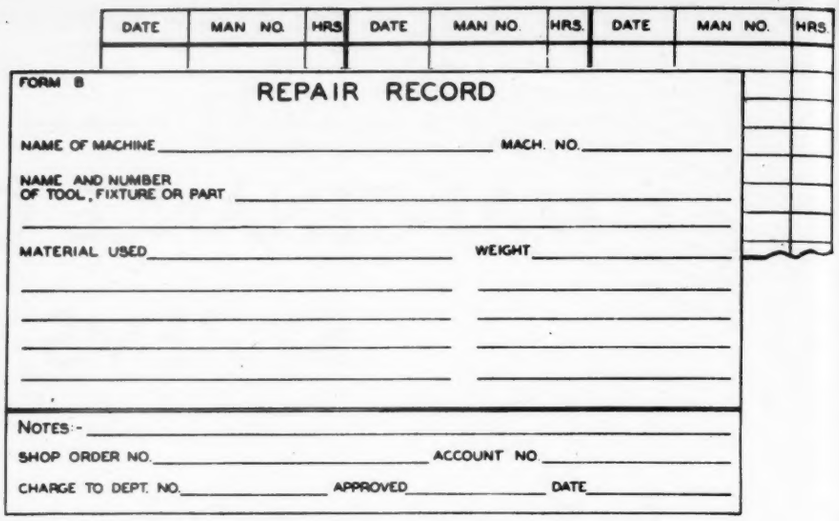


Fig. 5—Form B, obverse and reverse. This form is used by the Master Mechanic for recording costs. Actual size, 7x4¼ inches.

How Much Lubricant for a Ball Bearing?

PAUL J. ANDERSON

Chief Electrician
Link-Belt Company
Chicago, Ill.

THE BALL bearing seems to be a subject of discussion every time the ball bearing motor is mentioned. Ball bearing motors were designed primarily to reduce maintenance work and increase production. Whether used in a motor or in any other equipment, the ball bearing will have the same characteristics.

A ball bearing can be either over- or under-lubricated with practically the same disastrous results, regardless of its make or type of service. Under-lubrication means metal-to-metal friction which causes excessive wear and makes replacement inevitable. Over-lubrication, when it is done with grease, also will cause replacement of the bearing, but in a different manner. To say that there is too much grease in a ball bearing does not mean that the grease must be forced into the bearing cage or compartment under pressure. Any excess of grease over the exact amount required is too much.

Many equipment manufacturers have made tests to determine just how much grease should be used to lubricate the ball bearings in their equipment, and the results are available to all users of such equipment. If too much lubricant is used the ball bearing soon will become overheated. Such overheating sooner or later will cause bearing trouble, unless the bearing can relieve itself of the superfluous lubricant. Overheating causes expansion and consequent binding of the balls and ball races. Such expansion also tends to loosen the inner ball race from the shaft. The inner ball race is held in position on the shaft merely by a vacuum or a snug fit; therefore it is loosened with any appreciable rise in temperature. Because the ball bearing is made of hardened steel and the shaft of a softer steel (either cold-rolled, 0.40-per cent carbon, or nickel) it can be understood easily that the shaft will wear rapidly when the ball race is loose on the shaft. Also, when a ball bearing is overheated, the outer ball race might loosen in the cage and, because the cage usually is of cast iron,

cage wear will result. Finally the over-lubricated ball bearing might grind itself to pieces if one or more of the previously mentioned results do not happen first.

A better understanding of the consequences of improper lubrication can be obtained by a study of the accompanying curves and their explanations which follow.

A 1-hp. motor was brought up to its no-load speed of 1,800 r.p.m. with no lubrication other than a thin film of oil on the balls and ball races of the bearings. Then the current was cut off, and the speed was observed at specific time intervals during deceleration by means of a tachometer and a stop watch. The result is shown in Fig. 1 in the form of curve *D*. Next, grease was added until ½ oz. of grease was in each bearing, and the test was repeated. Curve *A* is drawn through the points found. The ½ oz. of grease in each bearing was just a little more than enough to fill the ball races. Because this amount of grease was recommended by the motor manufacturer for use in the bearings the tests show that the manufacturer really knows the correct amount of grease to be used, regardless of what some people may think to the contrary.

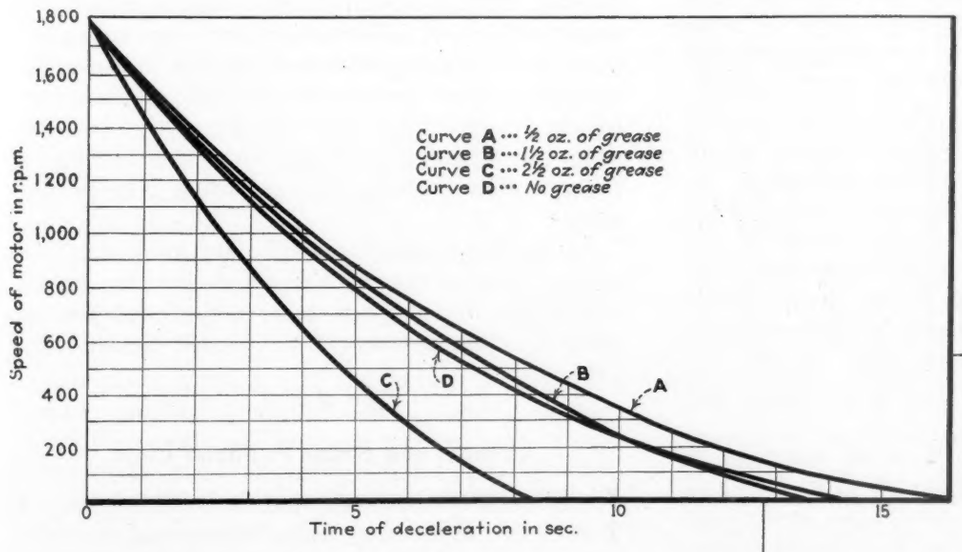


Fig. 1—The curves show the results of a no-load deceleration test on a 1-hp. ball bearing motor. For each of the four runs the motor was disconnected from the line when at its 1,800-r.p.m., no-load speed.

The curves *B* and *C* show the slowing-up effect of added grease.

Fig. 2 is derived from Fig. 1 by assuming that braking effect varies inversely with the time of deceleration. It should give a good idea of the inefficiency caused by the use of the wrong amount of lubricant on the motor.

When packed with 2½ oz. of grease each, the bearings were not under pressure. In fact this amount of grease was not enough to cause the grease to force itself out of the drain plugs at the bottom of the motor bearings.

In conclusion a point of advice is added: Be sure to use a grease in ball bearings that will not separate, thus losing its oil and leaving a core that will not retain its lubricating qualities.

■

Volume Changes in Metals During Casting

THE AMERICAN Foundrymen's Association and the Bureau of Standards have been cooperating in a study of the shrinkage of metals during casting and the influence of such shrinkage on the production of sound castings.

The total shrinkage of a metal or alloy for casting purposes has a profound influence on foundry practice. It affects the size of the pattern required to give a casting of definite dimensions (patternmaker's shrinkage), the design of a casting, the size, type, and location of risers and feeders needed, the liability of castings to crack in the mold, and the soundness of a pressure test.

A method has been developed for measuring the volume changes undergone by a metal or alloy with change in temperature as it cools from any temperature in the liquid state to ordinary temperatures. Three types of shrinkage are considered: (1) shrinkage of the metal in the liquid state, (2) during solidification, and (3) in the solid state.

The specific volume-temperature curve for liquid metal is constructed from data secured by application of the crucible immersion method; that is, by filling a crucible of known volume with the liquid metal at known temperature. Since the mass of the sample of liquid metal is the same as that of the sample at room temperature, the liquid specific volume may be readily calculated.

The difference between the specific volume of the liquid metal and of the solid metal at the melting point is the volume shrinkage undergone during solidification. In the case of an alloy, shrinkage during solidification occurs over a range of temperature.

Abstracted from U. S. Department of Commerce Technical News Bulletin of the Bureau of Standards, January, 1932.

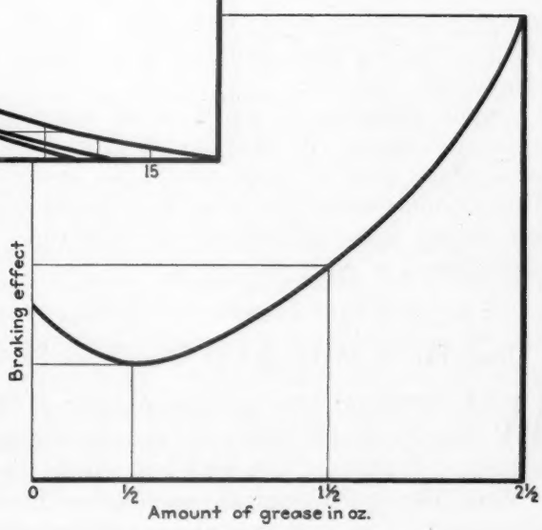


Fig. 2—A graphical representation of how friction in ball bearings varies with the amount of lubricant employed.

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

APRIL, 1932

Well Planned—Half Done

INSISTENCE on having an adequate force of engineers and draftsmen for preparing careful plans of all except routine work is one of the tenets of a plant engineer who has been unusually successful in organizing his department on an efficient basis. In this plant all work that involves building alterations, construction, or important repairs, erection or changes in location of machinery, pipe lines, and so on is laid out by a competent engineer. Detailed drawings are made when necessary, cost estimates are prepared, and the job is handled in general on a basis that tends to eliminate mistakes or errors in judgment, and foster the application of sound engineering principles.

This method of handling the work of the plant engineering department may seem to be unduly cumbersome and expensive. In the long run, however, it will prove to be cheaper than the practice, that is often followed, of notifying one or two of the foremen that such-and-such work is to be done, and leaving it to these men to plan the job. A foreman may be a splendid mechanic and a good manager, but he may be decidedly lacking in the engineering knowledge and ability required to lay out an important job properly. Usually his time can be spent to much better advantage in directing his men and seeing to the many details that are properly the foreman's responsibility. Failure to realize these facts may account for some of the slipshod, bungled work that is not infrequently seen.

Proper planning of work is an essential to proper execution. In emergencies short cuts and quick action may be imperative, but under any other circumstances time spent in planning invariably means a better-looking job and time and money saved in doing the work.

■

Don't Fail to Make Use of Our Check Sheet

WE THINK that we presented our Plant Survey Check Sheet at the psychological moment. It reached you with last month's issue.

Why the psychological moment? Because since that time we have received gratifying reports of resumption of industrial activity. Chief among them is the report of increased Ford production, which has affected many makers of parts.

Other reports tell of a thousand men rehired by Mansfield, Ohio, plants, worthwhile additions in Lorain and Cleveland, 600 workers recalled by a chinaware maker, 450 by a manufacturer of clay products. Five shoe factories report doubling their payrolls recently, and a rubber products plant has started on a 3-shift, 5-day schedule.

If these bright spots are the forerunners of widespread better times, your plant may be next in the order line. Are you ready? Or will you have to secure equipment and supplies after the orders come in? Will your lack of preparation force quotation of delivery dates that will drive the orders elsewhere?

Maintenance Engineering's check sheet was designed to help you get ready. The answers to the eight pages of questions will constitute a detailed report on the condition of your plant. You will be able to draw from the report lists of equipment and supplies that you must have immediately to bring your plant up to fighting strength. You will see what arrangements for supplies to be used in the future must be made and, if you believe in preparedness, will find out which supply distributors and manufacturers are going to be able to service you without delay.

Members of *Maintenance Engineering's* staff in their recent field trips have found a sincere appreciation of their check sheet and have been told of orders for equipment and supplies in the making. Indications are that the first-line plants really will be ready. The sheet and the motive back of it are parts of our campaign for preventive maintenance; they are aimed at preventing unpreparedness.

If, by any chance, you have not made full use of your copy of the check sheet, do it now. In all probability you are not doing a thorough job of preventive maintenance if you let the opportunity pass.

■

Cheaper and Better Artificial Light

INTENSIVE research that is being conducted on artificial lighting media has opened up some interesting possibilities that may profoundly affect lighting practices in the future. It is a matter of common knowledge that great improvements have been made in the incandescent lamp, since Edison gave it to the world. Substitution of a metal filament for the carbon filament originally employed, development of gas-filled lamps, and various other changes have served to increase the efficiency of the incandescent lamp manyfold, and give a much more desirable quality of light.

Despite these notable improvements the

present-day incandescent lamp is woefully inefficient, giving less than 10 per cent of the theoretical possible efficiency of a light source. Thorough investigation of all metals that would conceivably make good filaments has shown that no other element can compete with tungsten. As matters stand now, it appears that few if any radical improvements in incandescent lamps can be expected.

Realization of this condition has focused attention on the possibilities of using electrical discharges through gases as a light source. The application of luminous discharge tubes is familiar to everyone in the form of neon tube signs and mercury vapor lamps.

Many problems still remain to be solved before gas discharge lamps will have been developed to the point of simplicity and universal application that now characterize the incandescent lamp.

The science of artificial illumination has drawn much attention of late years, as its importance has become better appreciated. For some time to come the advances that are certain to be made will bear close watching by every plant man.

■

We Congratulate Dr. Langmuir

REASONS for the honors that were recently bestowed on Dr. Irving Langmuir, associate director of the research laboratory of the General Electric Company, will be apparent to all electrical men in industry and receive their hearty approval. Recognition of the contributions of this distinguished scientist took the form of a gold medal, an honorarium of $10,000, and a certificate presented by *Popular Science Monthly* as an annual award for notable scientific achievement by an American.

The first and one of the greatest of Langmuir's many contributions was the development of the so-called gas-filled incandescent lamp, which contains nitrogen or argon. It is estimated that these lamps save industry and the public in general a million dollars a night—$365,000,000 a year.

As the result of his work on the incandescent lamp there came important discoveries that led to the production of electron tubes far more powerful and useful than any previously known. Such tubes have made possible the great development in radio broadcasting and communication, and the widespread use of electron tubes in electrical control and other applications.

Likewise of outstanding importance was Langmuir's development of electric welding by the atomic hydrogen method. It involves passage of a stream of hydrogen through an electric arc. The intense heat of the arc disintegrates the hydrogen molecules into atoms, which later recombine to form molecules and in so doing produce exceedingly high temperatures. The atomic hydrogen process has made it possible to produce highest-quality welds in metals that formerly could not be welded at all, or with only indifferent success.

Langmuir's work has given wonderfully effective tools to maintenance engineers. He is richly deserving of the honors and acclaim that have come to him. It is earnestly to be hoped that his fruitful genius may continue to enrich science and industry for many years to come.

■

Needed: A Safety Walkway Code

SLIPPERY or uneven walkways often look innocent enough, yet they present one of the greatest hazards to human life in industry. According to the U. S. Bureau of Vital Statistics, the annual number of deaths in this country in late years from falls is over 17,000. It is estimated that a large part of these fatalities are caused by slipping and tripping on walkways—stairs, floors, runways, and streets.

Engineers and architects in close touch with the problem are in agreement that, if all walkways were constructed and maintained according to specific standards of safety, many of these lives could be saved. Such an objective requires a definite standard or yardstick for determining whether each walkway surface is hazardous or safe—in short, a safety code for walkways is urgently needed.

Commendable progress has been made toward the formulation of such a code. In 1923 a sectional committee, organized by the American Standards Associaton and sponsored by the American Society of Safety Engineers and the American Institute of Architects, started to work on the problem. Later a committee of manufacturers and distributors of walkway materials was formed, through which a research fellowship at the National Bureau of Standards in Washington was instituted to determine the frictional resistances for various walkway surface materials. Outgrowth of this fellowship is Research Paper No. 204 of the National Bureau of Standards entitled: *A Method of Measuring Frictional Coefficients of Walkway Surfaces.*

Although this paper is a step in the right direction, there is considerable work yet to be done. What is needed is a finished code enacted into a law that specifies the minimum coefficients of friction required for each walkway surface in designated locations and under all possible conditions. Because maintenance engineers are directly concerned with safety they can be depended upon to lend enthusiastic support to the speedy formulation and enactment of such a code.

PLANT ENGINEERS' FORUM

A new question is presented each month, and our readers' answers to previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

Regular Foremen's Meetings?

George Shipman and Frank Fulleger are driving home after a session of "penny ante" at the club. Because the game broke up promptly at midnight as scheduled, neither of the two men is too sleepy for a final chat.

* * *

"Glad we stuck to our quitting time; aren't you, Frank?"

"Got to agree with you, George, even though I did lose 60 cents. But it was worth that much and more to get together with the old gang."

"Speaking of get-togethers, I called at your plant yesterday afternoon on some business with your boss. Afterward I dropped into your office to see you. As usual you were not in. Your assistant told me you were attending a foremen's meeting. That's something new at your plant, isn't it? What's it all about, Frank, and why where *you* there?"

"Sorry you missed me again, George, because there are a lot of things at the plant I want to show you. As for the foremen's meetings, they are something new; yesterday's session was the first. All our foremen—both production and maintenance—meet twice a month for an hour to discuss their problems with one another. The production superintendent and I were there yesterday as silent delegates—we took no part in the meeting, which was run entirely by the foremen themselves. After a few more meetings we won't need to attend at all."

"Sound's interesting. But how did your shop get along without its foremen? What was discussed? Do you think the meetings worth the necessary time and effort?"

"We made each foreman responsible for his department when he was at the meeting. The result was that most of them left their departments in charge of capable assistants. Although there were a few minor troubles in the plant yesterday during the meeting, I believe we will work it out soon so that the foremen won't be missed for that hour.

"After electing a chairman, the boys discussed production, maintenance, and safety problems. At first some of them were afraid to get on their feet and speak out, but they were warming up in great shape at the end of the meeting.

"Yes, I certainly do think the meetings are well worth the necessary time and effort, George. I believe that they will bring about closer cooperation and a smoother running organization because each foreman will obtain a better understanding of the other's viewpoint. This closer cooperation should make each one of them realize more fully his responsibility for breakdowns, accidents, and production delays. Therefore it should not be long before all three of these enemies of efficiency are reduced considerably."

"Hope you're right. Keep me posted on how it's coming along. If your experiment works as well as you think, we'll have foremen's meetings in our plant. Here's where I hop out. Goodnight, Frank."

* * *

It does seem a good idea, doesn't it? Such or similar foremen's meetings probably are being conducted or contemplated in the plants of many of you readers. Let's hear what you have to say about them.

Should there be regular foremen's meetings on company time?

If so, should the meetings be conducted by the foremen themselves or by the management? How often should they be held and what should be discussed?

If such meetings are being held in your plant, what are their advantages and disadvantages?

Readers' Answers to Previous Questions

What Preparation for Recovery?

(Question presented in the March issue)

WHEN industrial activity is brisk much of the inefficiency of men, methods, equipment, and material is overlooked. At such times a profit is being made and, in the clamor of delivering the goods, the best ways and means and lowest cost seldom are combined in full measure.

During a lull, such as the present period, an ideal opportunity presents itself for a complete check-up. This opportunity passes by with nothing gained unless those in charge of plant equipment and operation have not only the responsibility but also the authority to plan and equip for more efficient operation. With keener competition such a procedure becomes almost essential. Many of these objectives can be accomplished with comparatively little cost.

Men and Methods—All efforts should be made to keep the men productively on the job at maximum efficiency. A study may show that this objective means a rearrangement of some existing equipment. Many types of work that previously were not thought to lend themselves to the application of wage incentives are now being studied, and wage incentives are being applied at a profit to both men and management. In such studies it often is found that there are many square pegs in round holes that might be changed around advantageously.

The study also can be applied to the engineering and planning sectors of the maintenance organization. Where this department must work on a curtailed time schedule and where the cost for carrying out these improvements must be kept at an absolute minimum, much of the necessary work can be done by those on salaries. These efforts should not be focused upon the shop alone but should extend to office and planning systems, such as improving or simplifying the methods, files, and drawings.

Inspection and Service—This period is an ideal time to make a thorough inspection and service check-up. Every endeavor should be made to cover equipment that is difficult to shut down when it is going full blast. Many establishments are allowing thousands of dollars worth of equipment to depreciate unduly and go to waste simply because they have not prepared such equipment for its present idleness by proper greasing or other protective measures. Of course such equipment will be useless when called upon to function again.

Tools should be kept in good shape, and a complete check-up should be made as to whether or not they are the best available for their specific purpose.

Materials used such as steels, fittings, and other supplies should be gone over carefully to weed out that which has become obsolete and should be replaced by something better that has since made its appearance. Similarly, a compiled list of slow-moving or dead stock will be a valuable guide to check against before ordering new material. It also is desirable that the scrap pile be gone over minutely for items or material that might be salvaged or turned into a byproduct.

Expenditures—For the most part the foregoing items are those that can be investigated and carried out with little additional cost. New developments in equipment should be investigated thoroughly at this time. Where records and cost studies show unquestionable savings such equipment should be purchased and installed at the earliest convenience to stimulate business. Where such funds are not available all possible data, quotations, and records should be on hand in preparation for the time when conditions will permit the necessary approval of expenditures.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company, Niagara Falls, N. Y.

FOLLOWING is a description of the work done at our plant to prepare for recovery:

Because fire destroyed a wood building of our plant we constructed a new steel addition. While this work was being done we overhauled practically all of the machinery going into the new building, and one new machine was purchased. Wiring to all machines was placed in conduit and performed in accordance with the latest electrical code.

New repair shop equipment was installed, and several novel features introduced. The lighting system was revamped, and all wiring placed in conduit. Convenient switches were located near the machine operators to facilitate turning out lights when not in use. This arrangement has saved us considerable money in our power bill. On night work operators now do not need to burn any more lights than they require.

Machinery was rearranged so that our materials now move in a straight line from raw material to finished product. The outside of our building was repainted with an aluminum paint, whereas the interior was painted industrial gray. Each machine also was painted this color. Trucks were refinished in aluminum. New and more convenient toilets were installed. Old water piping and air lines were renewed. Damaged window panes were replaced, and the windows cleaned. The office was refinished inside.

All this work was done some time ago. Recently, however, the controllers and grids of the electric traveling crane were overhauled in anticipation of future business. When business picks up we feel that our plant will be in good shape to handle its share.

GRADY H. EMERSON, *Chief Electrician*
Reed Brothers Stone Company
Birmingham, Ala.

THERE is a silver lining to the present dark cloud of depression, and it is represented by the opportunity afforded us by curtailed production to put our plants in order. Many factories were working under pressure for several years before these slack times, and much-needed maintenance work often had to be deferred in the mad rush to increase production. Only

the most urgent repairs were made, and equipment could not be shut down for inspection or overhaul at the proper intervals because manufacturing operations could not be interrupted.

This period is an ideal time to do this needed overhauling. Material costs are low, and we have ample men available for the work. We know that business will pick up soon, and we must be ready to take care of our share of it.

In our plant we have been inspecting carefully the equipment in each department and listing the repairs needed. We also are analyzing our operations in an endeavor to improve our equipment and, wherever possible, we are replacing obsolete machines with more efficient equipment. We are proceeding with all of this work as time permits and are deriving a two-fold benefit from it.

First, we are getting our plant in first class condition so that we can carry on efficiently when prosperity returns. Second, we are maintaining our organization and avoiding discharges that would add to the unemployment problem. We feel that this policy is absolutely necessary if we intend to maintain our position in the industry and that the money we are investing in maintenance and improvements at this time will pay substantial dividends in the near future.

C. W. SCHWABE
Superintendent Mechanical Department
Mallinckrodt Chemical Works
St. Louis, Mo.

Should Maintenance Methods Be Given Publicity?

(Question presented in the February issue)

IN CONTRAST with the traditional secretive policy of business men a free interchange of ideas and experiences generally has been considered to be characteristic of the intercourse of professional men. Nobody knows what doctors talk about when they get together, but the layman credits them with exchanging experiences for the general benefit of mankind. Professional engineers have been similary frank in their local and national meetings.

Because maintenance engineering is looked upon as a profession it would be surprising to learn that this interchange of ideas among its members is either less common or restrained. But, as maintenance engineers progress, they are showing more desire to reveal their methods.

A company that permits its maintenance engineers to exchange its maintenance methods with others is helping itself to good publicity. Furthermore, good will and recognition always follow the publication of better methods. It is the intellectual force controlling an undertaking, not its manufacturing processes, trade secrets, or special equipment, that insures its success.

A tendency of all of us is to believe that it is impossible for anyone else to do any job in our line of work better than ourselves. Imbued with this feeling of superiority we strive anxiously to protect our enterprises from companies many of which long ago progressed beyond the methods on which we pride ourselves.

Trade secrets usually are over-rated possessions. Investigation will prove that most of the supposedly secret processes or methods are used in other shops. We can learn something from even the most unprogressive enterprises because, in them, we can see how things should not be done.

HARRY KAUFMAN, *Engineering Department*
Naval Aircraft Factory, Philadelphia, Pa.

IN TAKING up the discussion between Frank and George on this subject we must distinguish definitely between maintenance methods and manufacturing processes. In the case of the latter, if a manufacturer can design a special machine or originate a process that will enable him to manufacture an article more economically than his competitor, it is well and good for him to keep his secret. But, when it comes to a question of methods pertaining to the maintenance of machinery and buildings, he should be willing to share his experience with the other fellow.

Every maintenance engineer should grasp every opportunity to visit other industrial plants and to discuss maintenance problems with other engineers. In these visits are found the best source of information for modern and up-to-the-minute methods of industrial maintenance. If all plants maintained strict rulings that kept maintenance methods secret, what would become of this source of information? Plant visits would, of course, be impossible. On the other hand the other fellow can profit by visits to our plant, and we benefit also by his visit if we discuss our problems with him.

The most important thing to be remembered when forming a publicity policy is that we, ourselves, do not know everything. We can best learn by coming into contact with others and talking over maintenance problems. If we are unable to exchange information because of a plant ruling we soon will find ourselves standing by while the rest of the world goes on.

E. L. GLOSSBRENNER, *Engineering Department*
Reynolds Metals Company
Louisville, Ky.

I BELIEVE that maintenance methods should be given publicity. Knowledge gained by experimentation or through long experience on one type of machinery may be needed urgently by some other maintenance engineer. While you are devising new methods in the maintenance of one type of machinery, another maintenance man is doing the same thing on another type of equipment. An exchange of these experiences will benefit you both. But, if each of you keeps his method a secret, both of your firms will lose time and money. Because there are so many different methods constantly being developed it is impossible for one firm to learn or know them all.

Secret processes and formulas, however, should not be publicized because such publicity may undermine the business. Yes it is true that processes can be patented but, unless the company is a large corporation with plenty of money to fight infringements, a patent doesn't mean much.

J. CONRAD WATSON, *Master Mechanic*
Franklin Pottery, Lansdale, Pa.

IN DISCUSSING this question the marked difference between maintenance and production methods must be borne in mind. Of course, when a great deal of money and time has been spent on the development of a production method, it cannot be expected that it may be broadcast to the world. But, where no breach of confidence is involved, any policy that locks the door on exchanging maintenance methods would appear decidedly short sighted.

If a closed door policy were followed by every owner of equipment the entire mechanical equipment industry could make little advance because research work under operating conditions would be at a standstill. Furthermore, valuable ideas that at present are available to all, either through reports or the pages of technical journals, could not be obtained. It seems logical therefore to conclude that, if the publicity will not jeopardize the companies concerned, the exchange of information on maintenance methods is beneficial to all.

M. C. COCKSHOTT, *Mechanical Engineer*
J. B. Gill Corporation, Ltd.
Long Beach, Calif.

How Valuable Are Professional Plant Surveys?

Question presented in the January issue

MOST of us are a little like Frank Fulleger, inclined to be a bit resentful of any outside parties coming into the plant with the avowed purpose of showing us how we have been losing money for years because we were not up to date. However, the fact that we are not up to date is perhaps one of the things that ails business today.

There is always a chance for improvement and, whenever we feel that there is no better way of doing things than ours, that is certainly the time when we start slipping. It behooves the maintenance head to welcome advanced ideas, such as are forwarded after a survey by those whose business is the installation of modern engineering ideas and methods.

I believe that we are suffering from a lack of proper distribution of what we do produce rather than from overproduction. This condition is caused either by prohibitive costs to the customer at his delivery point or by lack of adequate customer contact. Let us, therefore, welcome any proved means of cutting our costs to rock bottom, start the wheels spinning on output, and so encourage people to start buying, giving them more value to make up for their reduced earning power.

CHAS. H. WILLEY, *Superintendent of Manufacture*
Hoyt Electrical Instrument Works
Penacook, N. H.

THE PROFIT derived from the surveys of outside engineers depends upon many factors. Most professional surveys are made with the full consent of both the management and the plant engineer. When the management of a plant requests an outside survey without taking the plant engineer into its confidence it is probably because the management has lost faith in its engineering force and employs such a method to check the truth of its opinion.

More often it is the plant or maintenance engineer who, with the consent of the management, requests surveys. It is not possible for an engineer to be so well posted on every phase of his plant that he can become an expert on each of the numerous subjects or operations. Generally he is a man who specialized in one trade or profession—for example, as a mechanic or an electrician—to start with and later developed exceptional executive ability and all-around knowledge.

Because many maintenance engineers realize the limitations of their knowledge and experience they are prompted to cooperate with specialists on such subjects as paints, lubrication, safety, belting, power drives, cutting oils, packings, working conditions, insurance, and job assignments, in the same manner as bookkeepers and accountants cooperate with the outside firms that come in to audit their books.

J. H. WICKMAN, *Consulting Engineer*
Long Beach, Calif.

TO ANYONE who has been through a period of plant surveys there can be no question but that such surveys are profitable. We must realize that, although we may be on the job day in and day out and may think that we know all there is to know about our specific plant, we cannot expect to see and know everything, and that such consultations usually are proved to be worth far more than their apparent surface value.

The reason that the majority of engineers seem to be against such surveys is that either they are not open minded or they are afraid of the facts that will be turned up in the survey. Many of these men use the excuse that the survey engineers are simply technical theorists who do not understand the needs of their specific job. Others quote mistakes that have been made elsewhere by the engineers making the survey. Of course, a few of these engineers do make mistakes for they are human like the rest of us.

I was at one time employed in an Eastern shop that had the reputation of being the last word in efficiency. All of us working for this plant prided ourselves in this efficiency until after our plant had been surveyed by a firm of expert engineers. When we heard that the survey was to be made we felt that it was unnecessary, and consequently expected to have quite a laugh at the expense of the outside engineers after they failed to find anything to improve in our plant. But, when they started to turn up our shortcomings, it was a different story. At first, it was almost impossible to believe the things that they found were wrong and were costing the company money. The result was that more than one survey was made and, after this experience, we were enthusiastic about them and cooperated in every way. As our "big boss" told us, the surveys were made not because we were not holding up our end, but because the outside engineers were specialists and consequently were able to do work that we were not expected, and did not have time to do.

Let us not forget that many heads are better than one, and that a new broom will gather dust from places skipped over by the old faithful one.

CHARLES R. WHITEHOUSE, *Standards Department*
The Holtzer-Cabot Electric Company
Boston, Mass.

QUESTIONS and ANSWERS

Motors in Foundry Service

I should like to have the opinion of readers with foundry experience on the following questions: (1) Is it justifiable from the standpoint of lower maintenance and repair costs to install totally inclosed or ventilated motors, in place of the ordinary squirrel-cage type, for driving conveyors, tumbling barrels, and other power-driven equipment in grey iron and steel foundries? Has anyone any figures on the average cost of maintenance for these two types of motors in foundry or similar service?

(2) How often in general should open-type motors in foundry service be blown out? On what basis should the frequency of blowing out be determined? What is the maximum pressure of air that can be used in blowing out foundry motors without danger of injuring the windings through the abrasive action of the dust? **T. O. D.**

Buffalo, N. Y.

■

Removing Oil from Concrete Floor

A portion of our plant that was formerly used for manufacturing has been converted into offices. It is planned to paint the concrete floor, but in many places it is soaked with oil and I am afraid that in these places the paint will not dry well or adhere. Washing with gasoline has been tried and seems to remove the oil from the surface of the concrete, but after a time the oil below the surface works its way up again. I should like to know whether there is any treatment I can use that will remove enough of the oil to prevent trouble when the floor is painted? **J.B.L.**

Brooklyn, N. Y.

■

Changing Motor from 25- to 60-Cycle Operation

I have a Westinghouse ¾-hp., 110-volt, 25-cycle, 1,425-r.p.m., type CAH motor which has to be rewound for 60-cycle operation. The bore of the stator is 3 in. in diameter, 2⅛ in. deep. There are 24 slots. Can some reader tell me the number of turns and size of wire to use in the new winding? **E.C.L.**

North Tonawanda, N. Y.

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

Replace Cables?

At full load the voltage at the terminals of two 40-hp., 220-volt, three-phase motors that drive large drying machines goes down to 195 volts. I presume that the No. 3/0 cable that feeds the motors is too small. We have had no trouble with these motors and I should like to know whether there is any good reason why we should put in larger cables. Would our power bills be affected in any way if larger cables were installed? **A.S.**

Chicago, Ill.

WITH both motors fully loaded the total current would be approximately 200 amp. and the power factor would probably be not over 90 per cent. A.S. does not state what the local conditions of the installation are, but one judges that the room temperature may be high. The National Electrical Code allowable carrying capacity for No. 000 copper conductor is 175 amp. for rubber insulation, 210 amp. for varnished cambric, and 275 amp. for other insulations; so unless rubber insulation is used, or unless the room temperature is extremely high, the conductors should have sufficient current-carrying capacity.

The length of feeder from the main switch to the motors is not given. This may be the important factor in deciding whether the voltage drop is excessive, in which case the conductor size should be increased. With a more or less constant voltage at the main supply point, a large drop between it and the motors will result in a higher power bill. It is even possible that the main supply voltage at the entrance point is already low and the power company may be able to raise it. It would be well to proceed as follows:

1. Check voltage drop between supply point and motor.

2. If the drop exceeds 10 per cent, increase the size of conductor to give minimum drop.

3. If the supply voltage is low take the matter up with the power company.

4. The size of the cable between the entrance point and motors could be increased to a size where the lower losses would decrease the power bill so that the increased investment charges would be balanced. To determine this, the actual load, power, and distance involved as well as the power rate details must be known. C. O. VON DANNENBERG

Altoona, Pa.

■

Oil- and Acid-Resisting Floor Covering

I should like to have some information in regard to a good material for covering a concrete floor which in some places is subjected to acids, and in other places to oil. Several floor coverings have been tried, but all have failed. **W.H.H.**

Chicago, Ill.

NEED of a really effective coating for concrete floors that will withstand the corrosive action of acid and oil contact is a serious one in many industrial plants, particularly those of a chemical nature. In our own plants where dyes, rayon, cellophane, and a wide range of chemicals are made, we have encountered a very difficult problem of this sort. Concrete floors, no matter how carefuly laid, soon disintegrate when subjected to acids, even though the acid may be very dilute. Oil also has a softening effect, so that after a comparatively short time the

floors have to be patched, or replaced.

Asphaltic mixtures of all types have been tried, without finding anything of outstanding merit. Hot bituminous applications stand up for a while, but eventually they become brittle, crack, and chip off. Asphalt emulsions when mixed with concrete and used for patching give fairly good results under certain acid conditions, but none of them can be relied on, and in time they break down.

Realizing the importance of this subject, the du Pont laboratories set themselves the task of developing a coating that would give satisfactory results. After months of work a number of coatings have been developed that have unusual resistance to direct acid contact. Further information on these coatings is given on page 151 of this issue.

ROY C. SHEELER
Assistant Manager, Prescription Paint Service
E. I. du Pont de Nemours & Company,
Philadelphia, Pa.

■

Motor Runs Below Synchronous Speed

I have a 2-hp., three-phase, 60-cycle, four-pole, 550-volt, type KT G.E. motor that will not come up to speed. It has 36 slots and is wound with 36 coils having 40 turns of No. 18 wire, and connected one circuit star. The span of the coils is I-8 slots. The rotor has a cast aluminum winding and is ok. It has 51 slots. There is about 0.015 in. air gap between the rotor and the stator. With the motor-generator test set running at full speed this motor will turn at about 150 r.p.m. and has considerable torque. If the m.g. set is slowed down to about 45-cycle speed the motor takes hold and runs in synchronism. On testing the original winding we could not find any defects in it, but concluded there was something our tests failed to show and rewound the motor. It had been in operation for some time. Can someone explain why this motor runs below synchronous speed? T.S.E.

Baltimore, Md.

ASSUMING that the stator winding is in good condition, I would say that the rotor is defective.

I have experienced the same trouble on more than one occasion with motors using a cast-aluminum squirrel cage on the rotor. A number of the bars will break in the slots, due perhaps to some mechanical strain produced during the casting process. Of course, these breaks are not externally visible and are very difficult to detect.

One test that has proven fairly reliable is to place the rotor on a growler that has a low-reading ammeter in the circuit and revolve the rotor in the usual manner. A defective rotor will cause a slight variation in the ammeter reading, whereas there will be no variation with a good rotor.

The fact that the rotor runs in synchronism at 45 cycles would seem to indicate that the stator is O.K. However, regardless of what the growler test shows, if another rotor is available T.S.E. should by all means try it in this stator. If he does so I think his trouble will be solved.

CHARLES L. RIECKE, JR.
Electric Supply Company
Charleston, S. C.

■

High-Temperature Grease

We use a large number of unit heaters driven by ¾-hp., 440-volt, three-phase, totally inclosed motors equipped with single-roll ball bearings with grease shields. The motor starting switches are at a convenient height for floor operation, but the steam valves are mounted close to the heaters, about 12 ft. high. Because the steam valves are so inaccessible the heater motors are frequently stopped without shutting off the steam. The heat then dries out the high-temperature grease in the motor bearings, so that when the motor is started again the bearings stick, the shaft turns in the inner race, and a fuse blows. Every time this trouble occurs it means replacing the bearings. We have considered a single control for the steam and motor lines, but the cost is prohibitive. Placing the steam valves so that they can be reached from the floor would be difficult and very expensive. Is there available a ball bearing lubricant that would stand the high temperature to which these motors are subjected? If not, how can this problem best be solved? R.C.H.

Paterson, N. J.

LOOKING at this question one is immediately tempted to ask why R.C.H. does not put extension handles on the steam valves, or babbitt chain runs on them, and let the operators close them from the floor.

Grease is not, in my opinion, the proper lubricant for these ball bearings. If the housings will allow the use of oil I suggest that R.C.H. try a very good quality of heavy filtered oil, such as extra-heavy turbine oil or one of the heaviest automobile motor or diesel crankcase oils. I believe that if the oil gages are changed so as to allow the balls just to dip into the oil at the botton, further trouble will be avoided.

H. D. FISHER
Plant Engineer
New Haven Pulp & Board Company
New Haven, Conn.

WE HAVE a number of unit heaters with motors pocketed in the heater proper. The motors in these units are sometimes shut off for several hours to several days or even weeks, according to the weather, but the steam is not turned off in the heaters. I have seen the temperature run up as high as 95 deg. C. but have never had the separation of the constituents in the grease that R.C.H. refers to.

If the bearing housings retain the oil, action of the bearing should not be impeded, unless the bearings stand idle for several months. I have had new motor ball bearings that would not roll freely, after they had been kept in stock for some time. A dry, scaley substance was found in the bearings that retarded rolling of the balls. A thorough cleaning has always put such bearings in good condition.

We are now using a high-grade, hand-mixed grease that has been found very satisfactory under all temperatures from 0 deg. F. to 200 deg. Fahrenheit.

As to the trouble R.C.H. is having with the races turning on the shaft, it is my opinion that he will find the bearings to be over-lubricated. I mean that too much grease is put into the bearing. If the bearings and cages are cleaned and the grease forced through the balls and races, without any surplus in the cages, the expanding of the inner race and consequent slipping of the race on the shaft will probably be eliminated.

PAUL J. ANDERSON
Electrician
Link-Belt Company
Chicago, Ill.

■

This Motor Slows Down

A 7½-hp., compound wound, 230-volt, 825-r.p.m. d.c. motor is giving us trouble. This motor drives an embossing paper machine, through a variable-speed transmission in order to vary the speed of the machine from 30 ft. a minute to 250 ft. per min. At about full speed the motor will slow down and almost stop, but the 30-amp. fuse protecting it does not blow and an ammeter put into the circuit shows that the motor is not overloaded. I should like to know what defects to look for and how to remedy them. S.E.G.

Reading, Pa.

TROUBLE with this motor is probably caused by the fact that the series field is bucking the shunt field. The series field current subtracts instead of adding to the shunt field magnetism, although this condition is not easily detected at light loads because the series field current is small and has little effect in neutralizing the magnetism produced by the shunt field. However, as the load on the motor is increased the motor takes more current and the series field, which is connected in series with the armature, decreases the shunt field magnetism in proportion to the applied load. Inasmuch as the torque depends on the sum of the field and armature ampere turns, the motor will slow down as the load is increased until a point is reached where the shunt field is entirely neutralized. Then the motor will stop and may start in the re-

verse direction, sometimes without blowing the running fuse.

The remedy for this truoble lies in reversing the series field connections, so that the series field will add to the shunt field, rather than subtract.

Milwaukee, Wis. J. F. WISINSKI

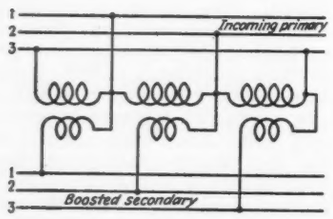
■

Why Shorts and Grounds?

In our plant we have a long secondary transmission line along which there is considerable voltage drop. To overcome this we have installed a set of booster transformers. The line is used to feed several well drills operating on 440 volts, and the operators on the drills use the 440-v. supply to fire their dynamite when clearing a hole. This momentarily puts a short circuit on the 440-v. line. Quite frequently, at the instant that they are firing this dynamite, some part of the portable cables or motors and equipment blows across or shorts to ground. This usually happens on the load side of the booster bank, that is, on some of the equipment opening on the boosted side of the line.

The booster transformers are Allis-Chalmers 5 kva., 440-v. primary, 110-v. secondary, single phase, connected in the line as shown in the diagram.

Do any of the readers see any connection between the boosters



being in the circuit and the trouble with the short circuits and grounds? How can this trouble be overcome?

Stoneco, N. Y. **C.F.S.**

I SUGGEST that C.F.S. place a lightning arrester in the boosted side of the line between any equipment and the cable used to fire the dynamite.

We all know that in the case of a short circuit a terrific load is thrown for a moment on the load side of the line. It seems to me that a good lightning arrester of suitable size could be used to advantage to protect the transformers and other equipment used here.

Kennedy, N. Y. PARKER A. LUCE

I BELIEVE that the booster transformers are to blame for the short circuits and grounds on the motors or cables. In a booster transformer the winding acts as an inductive circuit. When a short circuit occurs on the primary circuit the voltage drops suddenly, but when the circuit is opened again a high voltage is induced, similar to the action of an induction coil. The fact that the cables themselves short circuit indicates that the booster transformers are well constructed and in good condition.

It is always considered advisable when operating booster transformers to establish some neutral point for grounding, especially as a safety measure.

As preventive measure I would install a small transformer, or several if necessary, for firing the charges. These transformers should be 440 volts primary to about 50 volts secondary. Such transformers are designed for signal purposes. A momentary short circuit on these transformers would be of no consequence, and their primaries could be protected by fuses, the exact sizes to be determined by trial shots. This protection is recommended in case the secondary of a transformer becomes permanently short circuited unintentionally.

If the expense of such an installation is not considered to be justified, although I believe that it is when compared to the cost of delays and motor repairs under present conditions, a resistance may be purchased or constructed that will limit the short-circuit current at the instant of firing a shot. Choke coils can also be arranged to limit the current.

I do not believe that it is safe to put dead shorts on any circuit, without circuit breaker or other protection, or some means of limiting the current.

I believe that if ground pipes are available it would be well to ground the star of any star-connected motors located on the lines on either side of the booster transformers. This procedure will help reduce the surges if the firing method now in use is continued, and lessen the strain on the motor winding. If the transformers that serve the primary side of the boosters are star-connected it might also be well to ground this star.

Birmingham, Ala. GRADY H. EMERSON

■ ■

Leather Belting Now Sold by Thickness Instead of Ounces per Square Foot

THE AMERICAN Leather Belting Association has decided that for the greater protection of the consumers of leather belting, it should establish selling of this commodity by specifications of thickness instead of weight, thereby discarding the old weight terminology of "ounces per square foot" which may be varied by the mere addition of weighting materials to the leather, and does not necessarily always represent a differential in transmission values. This decision was reached after the Association had canvassed all manufacturers of belting throughout the country, with the result that 81 replies were received, all voting for the change.

It simplifies and makes comparatively easy the checking of each piece of belting to see if the average thickness is as ordered.

The thickness specifications now in effect for first quality leather belting are as follows:

Medium Single—
10/64 in. to 12/64 in.
Heavy Single—
12/64 in. to 14/64 in.
Light Double—
15/64 in. to 17/64 in.
Medium Double—
18/64 in. to 20/64 in.
Heavy Double—
21/64 in. to 23/64 in.

1. All thicknesses in this table are average thicknesses in inches, and should be determined by measuring 20 coils and dividing this value by the number of coils measured. In rolls of belting containing less than 20 coils the average thickness should be determined by measuring one-half of the total number of coils and dividing this value by the number of coils measured.

2. The classification of "Light Single" has been eliminated entirely.

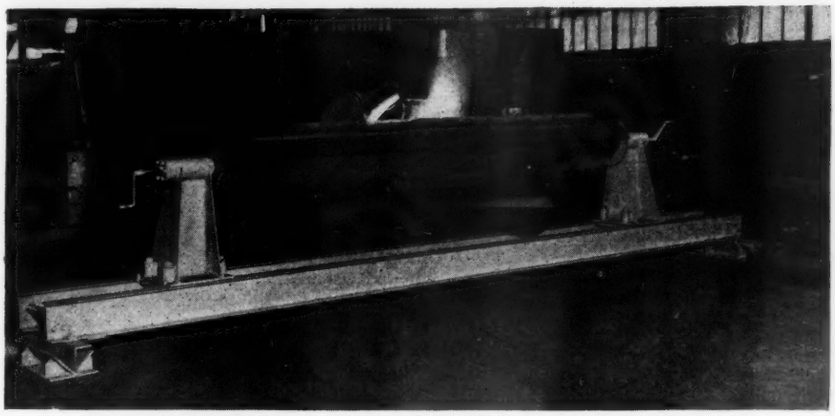
3. Uniformity: No point in either single or double belting shall be more than 2/64 in. thicker or more than 2/64 in. thinner than the average thickness.

4. The second and third quality brands of each manufacturer bear the same relative thickness to the manufacturer's first quality grades as they did in the past under the old ounces per square foot specification.

These thicknesses are now in effect and should be used by all buyers of belting in wording their orders. Every order for single or double should specify the thickness on the order. If just the words "Light," "Medium," or "Heavy" appear on the order these words now mean the thickness as per the table shown and ***not the weight as formerly.***

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs



Harnischfeger Welding Position Finders

Welding fixtures, known as position finders, for handling and holding heavy parts at such angles as to permit 45-deg. welding have been introduced by the Harnischfeger Corporation, Milwaukee, Wis. One model is manually operated and is designed for long narrow parts on which welding is to be done on all sides. This unit will handle structures up to 16 ft. in length. Revolution to a full 360-deg. turn is possible. This fixture is shown in the illustration.

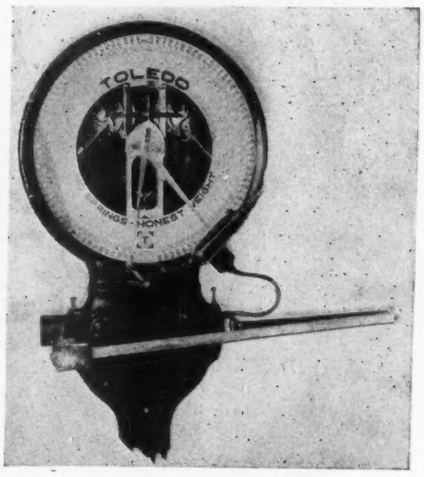
The second unit is of the table type and is electrically operated. The piece to be welded is clamped to the table and the bed of the table is then tilted (with electric motor drive) to the desired angle.

Table models are manufactured in two sizes: one for handling pieces up to 4,000 lb. in weight, the other for pieces up to 8,000 lb. in weight.

■ ■

Toledo Electric Cutoff Attachment

Toledo Precision Devices, Inc., Toledo, Ohio, announces the development of an electric cutoff attachment for increasing accuracy in industrial compounding and predetermined weighing. When used for filling containers to the same predetermined weight, no resetting or hand operations are necessary. For compounding materials a multiple adjustable indicator is available. After the indicators are set the operation is automatic. An operator presses an electric button to start the flow of each ingredient and to discharge the accumulated material. The attachment consists of a photoelectric tube, which effects a connection between the scale and a gate valve or conveyor. The light sensitive element is mounted directly behind a slot in the dial inside the dial housing of the scale. On the outside of the dial housing and in front of the slot is an electric lamp. The slot is between the light sensitive element and the electric lamp or light source.



In operation, the device works as follows: The photoelectric tube is attached to a scale provided with a clockwise front dial and a counter-clockwise rear dial. The rear dial is equipped with an adjustable indicator. The slot for the light sensitive element is located near the zero graduation. If, for example, batches of 120 lb. are to be weighed the adjustable indicator is set at 120 lb. on the rear dial. Next, the slot is uncovered, and the pressure of a button opens the gate. As the material falls upon the scale the adjustable indicator returns to zero, at which point the photoelectric cutoff closes the gate. Now the front indicator reads 120 lb. After the indicator is once set, the operation of weighing is automatic. The device connects to a standard light socket.

■

Globe Automatic Sprinkler

"Saveall" sprinklers, employing a solid chemical as the fusible element, have been announced by the Globe Automatic Sprinkler Company, 2035 Washington Ave., Philadelphia, Pa. Units are available in a wide range of temperature ratings—135, 150, 175, 212, 280, and 340 degrees.

The fusible element has an unchanging fusing temperature, each temperature rating being obtained by the use of a definite compound. As the surrounding atmosphere approaches the tem-

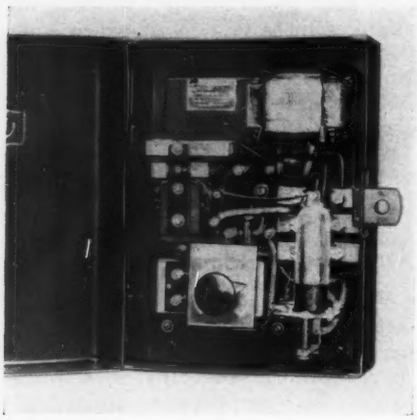
perature corresponding to the rating of the sprinkler the chemical compound undergoes a physical transformation, changing from a solid to a liquid.

The frame, of a central strut type, is of special bronze composition, die struck. The releasing members are of die stamped monel metal. Bearing surfaces are machined. Corrosion resisting materials are used throughout.

■

Cutler-Hammer Tube Timing Welder Control

Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis., announces the Bulletin 13101 tube timing control for spot, projection, and other forms of resistance welders. The device incorporates in its construction an electronic tube, provided to make possible a control accuracy of a fraction of a second. The unit has a range that is



adjustable up to 16 sec. Timing is adjusted by a knob inside the inclosing case. The control operates on a 110- to 550-volt a.c. supply of 25 to 60 cycles.

■

Caterpillar "Sixty-Five" Tractor

Caterpillar Tractor Company, Peoria, Ill., announces the "Sixty-Five" tractor. The machine will develop 68 hp. at drawbar and 79 hp. on the belt. Construction and design features are essentially the same as the other units of the line.

■

Link-Belt Shovel-Crane-Dragline

Link-Belt Company, 300 West Pershing Rd., Chicago, Ill., announces the K-48 shovel-crane-dragline. It is available in capacities ranging from ¾ to 2½ cu.yd. As indicated, it is an all purpose unit, serving as a shovel, a crane, a

trench hoe, or a dragline, and can be driven by a gasoline engine, diesel engine, or electric motor. All three power units are rated at 130 horsepower.

As a shovel it is equipped with a 25-ft. shovel boom, 17½-ft. dipper stick, and a 1¾-yd. dipper. As a crane the unit has a rated capacity of 32 tons in a 12-ft. radius and 10,400 lb. in a 45-ft. radius when it is equipped with a 45-ft. boom.

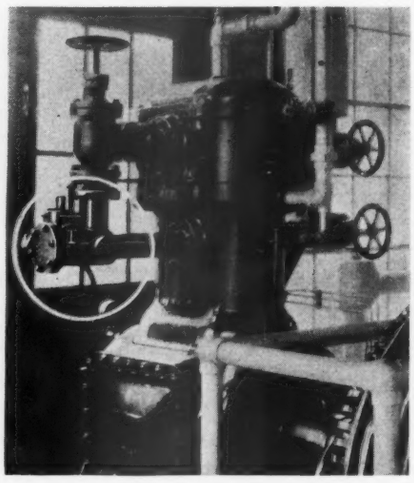
As a dragline it will handle a 1¾-cu.yd. heavy bucket or 2-cu.yd. light-medium bucket on a 45-ft. boom. As a trench hoe the character of the work and the digging depth determine the size of the bucket used. For normal digging depth in average soils a 2-cu.yd. solid-bottom bucket is standard.

■ ■

Electric Machinery Unloader For Ammonia Compressors

Electric Machinery Manufacturing Company, Minneapolis, Minn., announces the development of an instantaneous unloader for synchronous-motor-driven ammonia compressors. The unloader, in conjunction with automatic control for the motors, is designed to make the bypassing operation of the compressor entirely automatic. Automatic start and stop operation of the compressor units can be secured with the use of automatic compressor unloading. The compressors are started and stopped by brine thermostats, suction pressure control, or other means to maintain desired temperatures. Freedom is provided from shutdowns caused by power disturbances because the unloader keeps the compressor running through momentary voltage dips.

The unit is an automatic pressure-differential-operated bypass valve, connected between the suction and discharge lines on the compressor. The valve operates by the ammonia gas pressure differential and is controlled by a magnetic pilot valve which, in turn, is controlled by the frequency responsive relay on the synchronous motor starting panel. When the motor is started the pilot valve is energized and a small amount of high pressure ammonia gas is relieved in the unloader to actuate it. This gas is returned to the low pressure side of the system so that there is no leakage. The illustration shows the unloader applied to an ammonia compressor driven by a 60-hp., 240-r.p.m. synchronous motor. The unloader is shown within the circle.



■

Kirkland "Bulls-I-Unit"

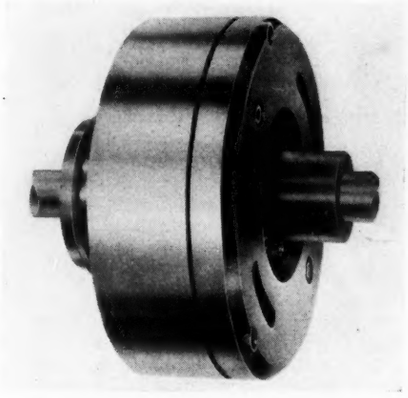
H. R. Kirkland Company, 70 East 45th St., New York, N. Y., announces a device for effecting visual signals known as the "Bulls-I-Unit." It is designed especially for panelboards, remote control, signaling, and annunciators. The unit in itself is a complete annunciator and consists of a light chamber, terminal block, socket, slip-fit cap, and a symbol insert. The device is installed by inserting it into a hole

1⅜ in. in diameter. The panel may be of any thickness up to 1⅝ in. The standard magnifying lens is designed to permit the number or signal to be seen from any angle. Colored effects are secured by the use of colored glass inserts. The socket is insulated from the chamber and takes a standard candelabra base lamp (including the 5-watt, 120-volt, S6 Mazda) or a miniature base lamp with adapter.

■

Dings Magnetic Friction Clutch

Magnetic friction type clutches have been announced by the Dings Magnetic Separator Company, Milwaukee, Wis. These clutches have contact faces on both sides of a spring disk which are squeezed between the magnet and armature elements when the coil is energized. Provision is made for adjustment to compensate for wear of contact faces.



Light springs on the armature holding bolts serve to expel the armature when the coil is de-energized.

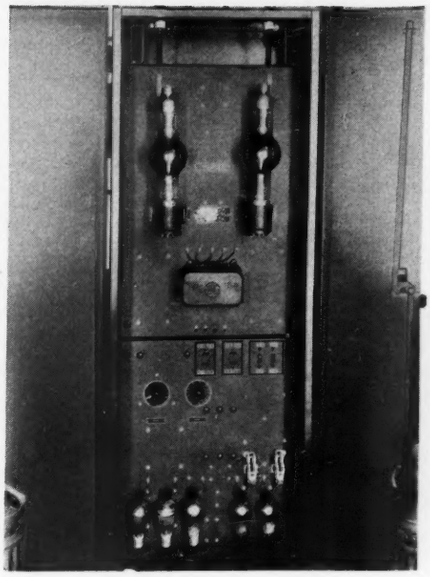
Units are available with and without ball bearings between the hubs of the two clutch members as operating conditions require.

■

General Electric Thyratron Welding Control

Thyratron tube timing control, announced by the General Electric Company, Schenectady, N. Y., permits close control of the frequency of current interruption up to 1,800 per min. This control equipment, designed to replace mechanical interrupters, operates in synchronism with the alternating current supply of the welding machine, and works in conjunction with General Electric welding control Type CR 7503.

Embodied in the control is a series transformer the primary of which is connected in series with the primary of the welding transformer. Its secondary is short circuited by two thyratron

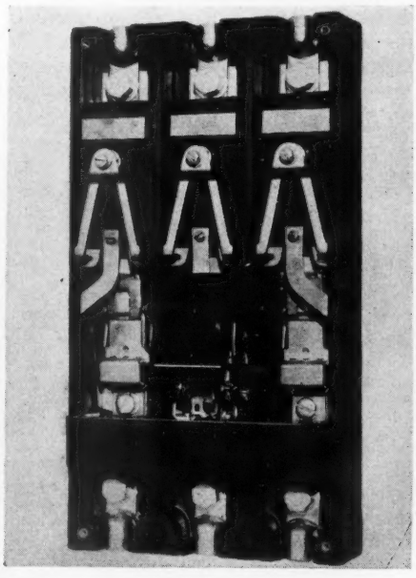


tubes. Welding current will not flow unless the grids of these tubes are properly energized. For controlling and energizing the grids of these thyratrons three small thyratron tubes are used. One in combination with a condenser acts as a timer and controls the grids of the other two small thyratrons which, in turn, control the two power tubes.

■

Westinghouse Type AB "De-ion" Circuit Breakers

"De-ion" circuit breakers, announced in 1929 for high tension service by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., are now available in industrial sizes, 50 to 225 amp.; 250 and 600 volts a.c.; 125 and 250 volts d.c.; 1-, 2,- 3-, and 4-pole. The completed line will include sizes as low as 15 amp. Breakers for 50 to 225 amp. are identical, with the exception



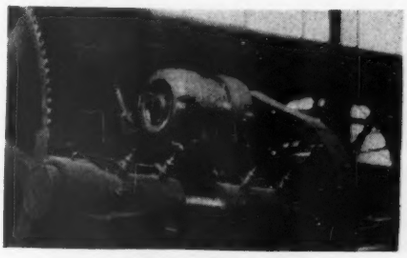
of the trip units by means of which the rating is varied. The mechanism is mechanically-trip-free and functions in hand closing and both hand and electrical tripping.

Use of these breakers is said to reduce the size of switchboards that would be necessary for heavy duty air circuit breakers of equal capacity. Four 225-amp., 3-pole, and eight 50-amp., 3-pole breakers on the 100-amp. frame can be mounted on a panel 22 in. wide and 90 in. high with approximately a foot of unoccupied panel at top and bottom.

■

Reliance Punch Press Motors

Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio, has developed a line of induction motors especially adapted for punch presses and machinery with similar operating characteristics. They range in size from ¾ to 200 hp. In the design of these motors the flywheel action



was considered. During the unproductive part of the operating cycle each motor delivers power to the flywheel. When work is being done by the flywheel the motor slips and permits the flywheel to carry the brunt of the load. The motors develop a starting torque of approximately 225 per cent and have a slip of from 8 to 12 per cent. Normal starting current is required. The motors are furnished with either ball or sleeve bearings and may be obtained in the open, fully inclosed, or fully inclosed fan-cooled constructions. The frame is fabricated from bar steel electrically welded.

■

Skala Carbon Monoxide Detector

Skala Research Laboratories, 2300 South 56th Ave., Cicero, Ill., announces that it has developed a small device, known as a carbon-monoxide detector, that will detect the presence of carbon monoxide gas in any building or garage before the gas has become strong enough to endanger human lives. The device is used in connection with a small radio vacuum tube inclosed in a telephone bell ringer box. Box and tube are installed in the building to be protected so that there is a free circulation of air around the instrument.

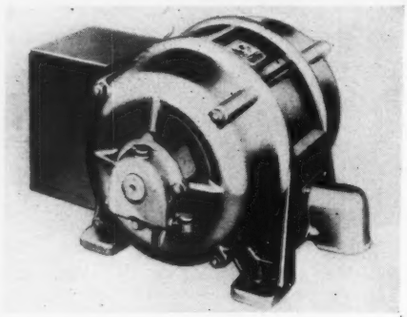
Diamond "Griptite" Belt Dressing

Development of a dressing for rubber belts known as "Griptite" has been announced by The Diamond Rubber Company, Inc., Akron, Ohio. Characteristics claimed for the dressing are that it is not greasy or inflammable, that it doubles the pulling power of the belt, and that its effectiveness increases with use.

■

Ideal "Noel" Capacitor Motor

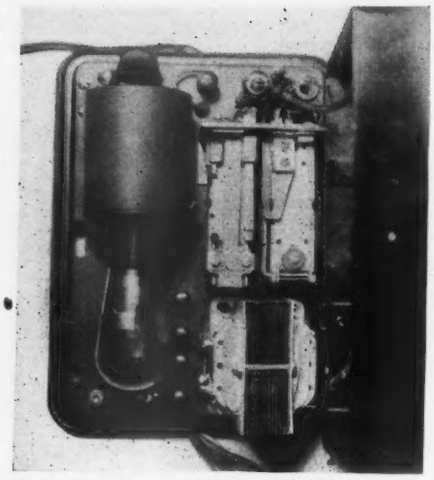
Announcement has been made by The Ideal Electric Company, Mansfield, Ohio, of the "Noel" polyphase capacitor motor. Claimed for the unit are the high starting torque and low starting current of the squirrel cage induction motor. No brushes, commutator, or moving contacts are necessary. Reported advantages over the polyphase induction motor are unity or 80-per cent leading power factor, higher starting torque, lower starting current, increased efficiency, and less slip with a resulting higher full load speed. Capacitors used are of the oil-filled, oil-impregnated, hermetically-sealed type with individually fused sections. They are assembled in steel cases with conduit connections for mounting on the wall or any convenient location. The motor also is made as a slipring, variable-speed induction motor in all sizes and speeds. This design is especially advantageous in a variable-speed motor as this motor will retain its high power factor at speeds as low as 50 per cent of standard rated speed. The unit is built in types to meet all starting torque and inrush classifications, including across-the-line starting in all sizes and speeds up to 200 hp. at 80-per cent leading or unity (100-per cent) power factor.



■

Skala Detecting Unit

Skala Research Laboratories, 2300 South 56th Ave., Cicero, Ill., announces an instrument for detecting electrical changes or lowering the conductivity of the surrounding atmosphere. Incorporated in the unit is a vacuum tube. Although designed primarily to detect fire or overheating by ringing a bell at abnormal temperatures, the unit also can be applied to electric measurements, signaling systems, and burglar alarms. The principle of the instrument depends upon the fact that the grid of a vacuum tube is sensitive to minute changes of electrical energy. Power is derived from a 110-volt, 60-cycle lighting circuit.



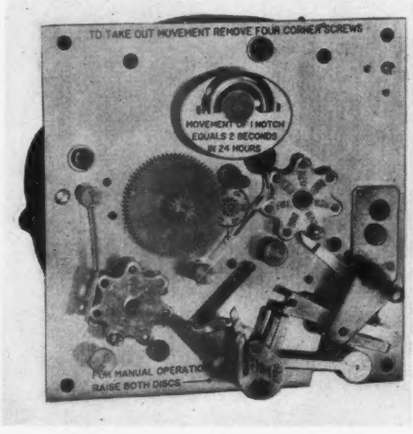
■

Sangamo Time-Switch Cutout and Cutoff

Sangamo Electric Company, Springfield, Ill., announces a Sunday and holiday cutout and an advance time cutoff for Type TM or TC time switches. The mechanism permits a wide variety of omitting operations.

Mounted on the front train plate and indexed by a stud located on the under side of the dial near its periphery is a daily index wheel in which pins can be inserted corresponding to any day in the week. Any pin in the index wheel moves a control lever, on the end of which is a small extension that prevents the switch from being turned on. At midnight, when the wheel is indexed for the next day, a spring restores the lever to its normal position.

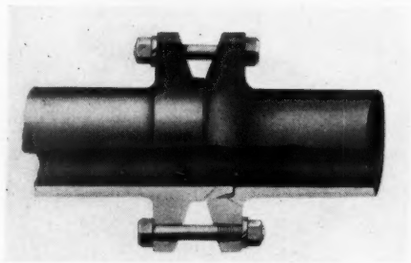
The advanced time cutoff provides a method for changing the time at which the switch turns off the circuit. It is actuated by another stud and index wheel. The illustration shows the movement of the instrument with the dial removed.


TO TAKE OUT MOVEMENT REMOVE FOUR CORNER SCREWS
MOVEMENT OF 1 NOTCH EQUALS 2 SECONDS IN 24 HOURS
FOR MANUAL OPERATION RAISE BOTH DISCS

■

Central Foundry Universal Pipe Joint

To provide a gas-tight joint for cast iron pipe under high pressures the Central Foundry Company, 420 Lexington Ave., New York, N. Y., announces the "Dual-Lok" universal joint. In construction a machined iron-to-iron joint is reinforced by a gasket on the lip of the male half. This gasket is installed so that internal pressure tends to compress the gasket into closer contact, so that an increase in pressure tends to tighten the joint. The jointed pipe is made in standard 6-ft. lengths. For air, water, and similar fluids rubber ring gaskets are used. The rubber gaskets for gas joints may be plain or tipped. Asbestos gaskets are available for oils, chemicals, and high temperature work.



■

Lincoln "Aluminweld"

The Lincoln Electric Company, Cleveland, Ohio, announces an electrode for use in welding sheet or cast aluminum known as "Aluminweld." The electrode is essentially a five per cent silicon aluminum alloy designed for either metallic or carbon arc welding. Other features claimed for the material are that its coating prevents excessive oxidation and dissolves any aluminum oxide that might be formed, and that the weld can be polished satisfactorily with practically no discoloration. When in use a short arc of approximately twenty volts should be held with the coating practically in contact with the work. The necessary current varies from 35 to 150 amp., depending on the size electrode and material to be welded. The electrode is produced in the $\frac{3}{32}$-, $\frac{1}{8}$-, $\frac{5}{32}$-ond $\frac{3}{16}$-in. sizes in the standard 14-in. lengths.

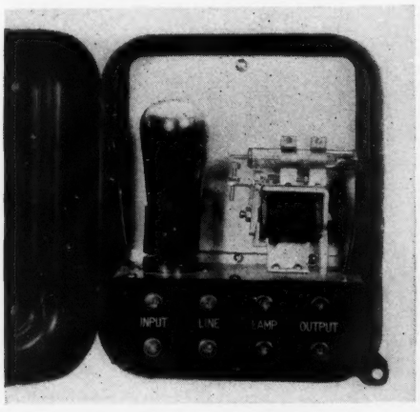
Burgess Micro Relay

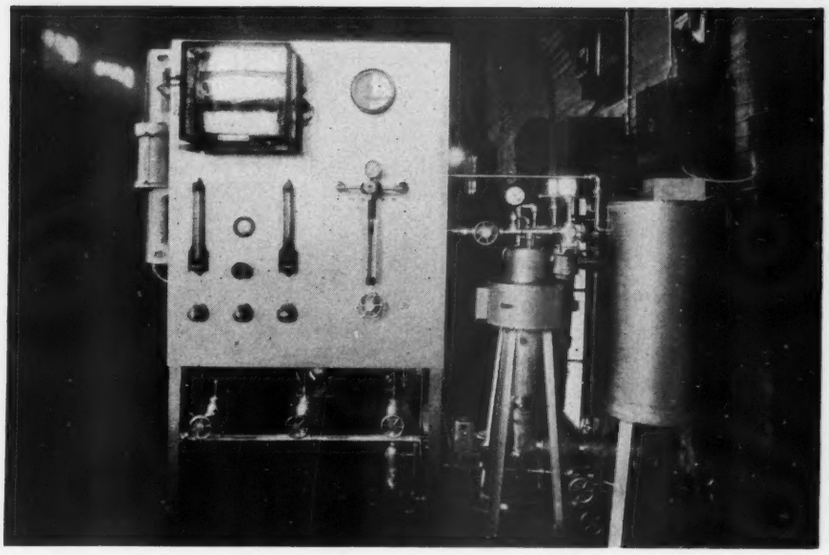
For controlling a current of six amperes at 220 volts with a flow of one-millionth of an ampere, an electronic relaying device known as the micro relay has been announced by C. F. Burgess Laboratories, Inc., 202 East 44th St., New York, N. Y. Because the relay transforms normally indistinguishable contacts into distinguishable useful forces, its greatest value is found in its use for control work, go and no-go, and maximum and minimum control settings on sensitive indicating meters and other apparatus. The device is especially recommended wherever it is desired to provide indication or control at some predetermined value as shown by any indicating instrument, or in industrial equipment wherein positive action must be obtained by the closing of an electrical circuit through a pair of contacts under a slight pressure.

The unit consists of an electronic tube, in the plate circuit of which is a normally closed mechanical relay. The relay is held open by the residual value of plate current with an unbiased grid. The controlling contacts are wired so that, when they come into contact, a negative bias is placed on the grid, immediately causing the relay to close. This action occurs even with high contact resistance in the order of twenty megohms; in fact, the relay will function with any contact resistance appreciably less than the insulation between the electrodes of the tube.

The relay is mounted in a metal cabinet measuring 7x8½x4¼ in. It may safely be used in explosive atmospheres because the contact is totally inclosed. A terminal strip inside the cabinet provides for connections with the external circuits. The unit is arranged to operate with a standard 25-watt lamp wired in series with the filament of the tube. This lamp serves the triple purpose of a resistor, pilot light to indicate that the relay is operative, and illuminator for the indicating instrument to which it is attached.

The unit is available in models for different applications, such as normally open or normally closed, 110- or 220-volt, a.c. or d.c., and for normal operation or time delayed operation.





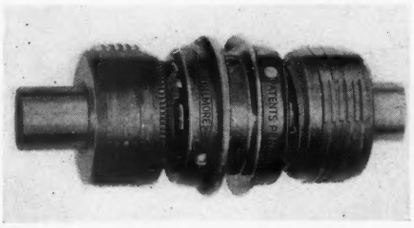
Westinghouse Ammonia Dissociator

Equipment for dissociating liquid anhydrous ammonia has been announced by the Westinghouse Electric and Manufacturing Company, Mansfield, Ohio. It is available in standard capacities of 50, 250, and 600 cu.ft. per hr. When units are operated at rated capacity, the dissociation is reported to be 99.5 per cent complete, so that each pound of liquid ammonia yields 45 cu.ft. of dissociated gas. Dissociated gas is free from raw ammonia and moisture.

■ ■

Morse Chain Company to Sell "Pullmore" Clutches

Morse Chain Company, Ithaca, N. Y., a division of the Borg-Warner Corporation, announces that it has been appointed sales agents for Morse "Pull-



more" Clutches, manufactured by the Rockford Drilling Machine Company, Rockford, Ill., another division of the Borg-Warner Corporation.

■

Page "Hi-Tensile" Electrodes

Page Steel and Wire Company, Monessen, Pa., has developed a type of coated electrode known as "Hi-Tensile." Claimed for the material are quiet operation and a minimum loss of metal caused by spatter. The structure of the weld is essentially the same as that of mild steel or boiler plate, except that it has a finer grain. The electrodes do not require reverse polarity for efficient operation. Other reported advantages of the electrode are that it can be bent to a reasonable degree without the coating peeling or falling off and that the coating is moisture proof and requires no baking before using.

■

Linde Tip Adapter

"Purox" 11-to-00 tip adapter for the "Purox" No. 11 welding torch has been announced by The Linde Air Products Company, 30 East 42nd St., New York, N. Y. By use of the adapter it is possible to use the stems and tips of the No 00-D aircraft welding torch and the stems and tips of the No. 00 welding and lead burning torch on the No. 11 welding torch. Because of the wide range of usefulness made possible by this adapter the No. 11 torch is especially suitable for use in garages and repair shops where a great diversity of work is encountered.

■

Raybestos-Manhattan "Condor" V-Belts

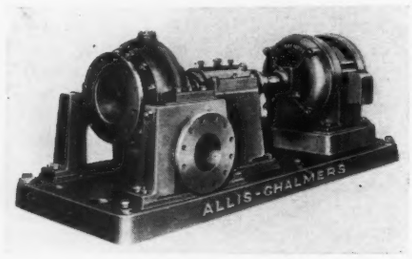
Two types of construction have been added to the line of "Condor" V-belts manufactured by The Manhattan Rubber Manufacturing Division of Raybestos-Manhattan, Inc., Passaic, N. J. In the "Whipcord" construction two layers of tie-gum are used to weld together the

whipcord and provide flexibility. "Plycord" is designed for heavy duty power drives. As the name indicates, heavy duty cords are used in its construction. Maximum stretch is claimed to be not higher than 1.9 per cent.

■

Allis-Chalmers SSA Centrifugal Pump

Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the SSA single suction centrifugal pump for handling acid in process work. All parts coming into contact with the acid pumped are made of chrome steel. To insure uniform expansion from the center of the pump when handling acids of high temperature the casing is supported on the horizontal centerline by brackets. In addition the casing is keyed on the vertical centerline underneath the water cooled stuffing box. Construction features include self-aligning, anti-friction bearings and a flexible coupling that



can be removed through the suction end of the pump without disconnecting the discharge piping or casing brackets, or disturbing the motor.

■

Bryant Flush Tumbler Switches

Inclosed flush tumbler switches for Type "C" gas-filled lamp lighting circuits have been announced by the Bryant Electric Co., Bridgeport, Conn. Cups are of black composition and handles of brown bakelite. Single-pole indicating; double-pole indicating; three-point; four-point; and single-pole quadruple-break, indicating types are available in ratings up to 20 amp. at 125 and 250 volts.

■

Lincoln-Schlueter Twin Disk Floor Cleaning Machine

For cleaning floors in industrial plants where grease, dirt, metal chips, and shavings accumulate the Lincoln-Schlueter Floor Machinery Company, Inc., 213 West Grand Ave., Chicago, Ill., announces the Type No. 77-1 "Industrial Special" twin disk floor machine. The two disks contain two 10-in.

brushes and clean in a 20-in. span. Brush speed is 285 r.p.m. Three steel gears incased in an aluminum grease packed case are employed in the driving mechanism. Rotating parts revolve in oversize ball bearings. A 1½-hp. ball bearing motor, either d.c. or a.c., is standard equipment. Both the guide handle and truck wheels are adjustable. Wheels are rubber tired and equipped with ball bearings. Two sets of circular crimped steel wire brush disks and 50 ft. of rubber covered cord with connectors are standard equipment. The machine weighs 170 lb. net.

■

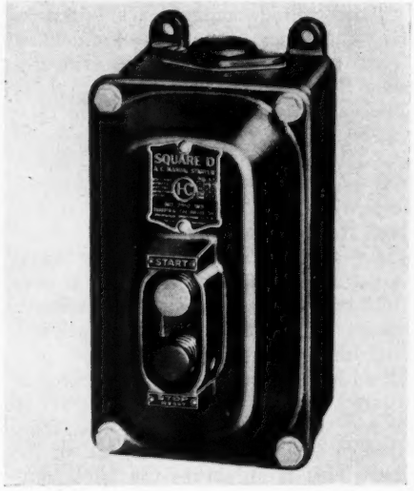
Medusa Announces the Formation of a Selling Company

Medusa Products Company, 1002 Engineers Building, Cleveland, Ohio, has been organized as a subsidiary of the Medusa Portland Cement Company. It will function as the selling company for such products as Medusa portland cement paint, floor coating and primer, as well as the entire line of rust-resisting coatings and technical paints manufactured by the Studebaker Chemical Company, Elyria, Ohio.

■

Square D Manual Starter

Class 2510 W6 a.c. manual starter of water- and dust-tight construction has been announced by the Industrial Controller Division of the Square D Company, 710 South Third St., Milwaukee, Wis. The three-pole unit is designed to control across-the-line single and polyphase motors of 2 hp. or less. It is suited especially to packing plant, creamery, flour mill, cement plant, foundry, and similar applications where extreme moisture and dust conditions are encountered. Overload protection is provided by time limit overload relays, which reset in front and require no replacement of parts after operation. Tripping of either relay opens all three lines.



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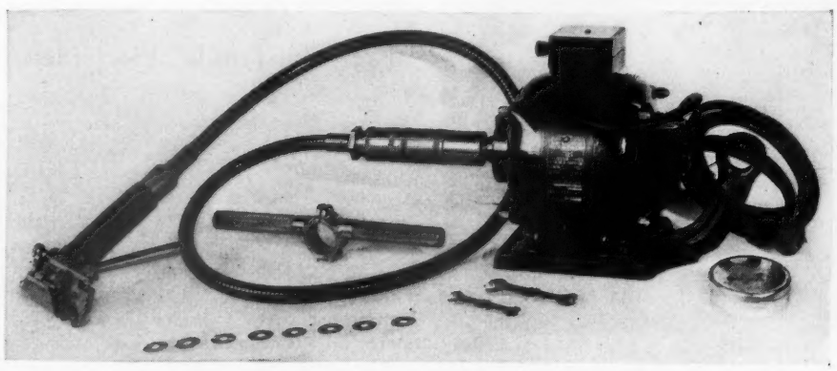
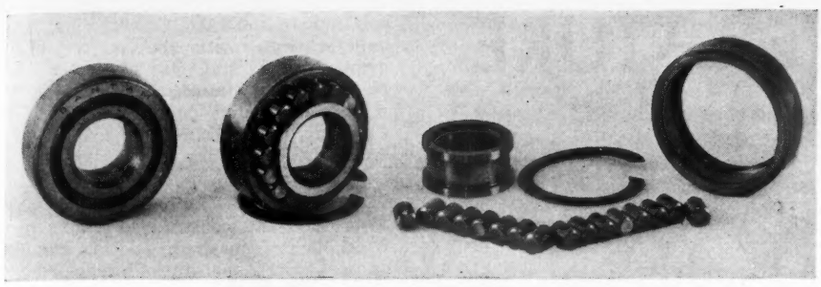
Ideal Mica Undercutter

Ideal Commutator Dresser Company, Sycamore, Ill., announces the "Universal" mica undercutter. The unit can be used on a commutator with but 2¾ in. clearance without the guide assembly attached or in a 3½ in. space with the guide assembly attached. A ½-hp. motor drives the cutter at 1725 r.p.m. Locking micrometers can be made for depth, width, and pitch.





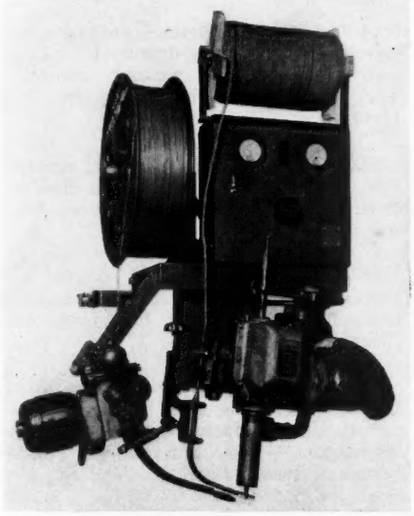
Bantam Radial Roller Bearings

Radial roller bearings have been announced by the Bantam Ball Bearing Company, South Bend, Ind. They are available in the standard ball bearing sizes in order to provide complete interchangeability. Two lips on the inner ring or cone and one lip on the outer ring or cup allow each bearing to take thrust loads in one direction. According to the announcement the radial load capacity is eight times that of a ball bearing of the same outline dimensions. Consequently this type of bearing is especially adaptable to applications in which the design will not lend itself to a larger bearing and where a larger load capacity than that of a ball bearing is desirable.

■ ■

Lincoln Automatic Welding Head

A wire feeding head that permits automatic arc welding with the shielded arc process by feeding filler metal into the shielded arc has been developed by The Lincoln Electric Company, Cleveland, Ohio. Automatic operation is secured through the use of the welding head and a fibrous autogenizer which is fed into the arc just in front of the arc travel. Provision is made for varying the rate at which the filler metal is fed into the arc so that the amount of metal deposited can be varied to meet the conditions demanded by the speed of the head and the type of weld being made. Because the rate at which the filler can be fed is varied independent of the speed of the head travel, only one size of filler metal is necessary for any type of work within the range of the machine.



fed into the arc flame. This autogenizer burns and forms a gas, so that the oxygen and nitrogen of the atmosphere are excluded while the metal is molten. The welding head utilizes a carbon arc around which is superimposed a magnetic field which directs the arc stream on the line of fusion. Thus full automatic control of the arc is obtained, maintaining the heat of the arc constant. Means also are provided for varying the speed of travel of the head.

Continuous filler metal is obtained from a reel mounted on the head and

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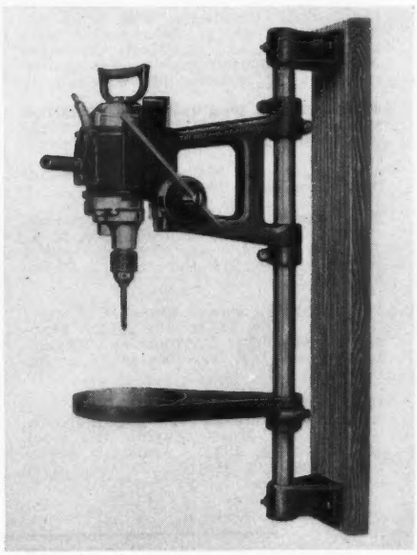
Hisey-Wolf Radial Drill Stand

Hisey-Wolf Machine Company, Cincinnati, Ohio, announces a post type radial drill stand with a sensitive rack and pinion feed adjustment. It can be furnished for all Hisey-Wolf portable electric drills up to and including $\frac{7}{8}$-in. capacity. The rack and pinion feed operates the same as the feed of an ordinary drill press. Motor holding brackets are designed so that the portable drill can be attached without removing any part of the machine.



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Tagliabue Combustion Indicator-Recorder

C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., announces an all metal automatic flue gas analyzer known as the "Tag-Mono" indicator-recorder. The instrument not only indicates and records the percentage of CO_2 but also gives an accurate record of the percentage of combustibles, such as $CO+H_2$ which may be present in the flue gases. The instrument works on the Orsat principle; it analyzes chemically and indicates and records electrically. Its illuminated dial and pointers can be seen at a distance of 30 ft. Records are made on a 9-in., 24-hr. circular chart with open graduations.

■

Skybryte "Rustox"

A protective coating called "Rustox," for preventing the spread of rust, and for preparing rusted metal surfaces for repainting has been introduced by the Skybryte Company, 1919 East 19th St., Cleveland, Ohio. The coating is a liquid which may be brushed or sprayed at any temperature above 35 deg. It is said to resist acid fumes, smoke, salt air, and to withstand temperatures up to 550 deg. Fahrenheit.

It is also available in pigmented form to be used as a vehicle for aluminum flakes, red lead, and graphite.

TRADE LITERATURE

For copies, address the manufacturers concerned

(102) AIR TOOLS—Electrically operated portable air hammers.—Portable Air Hammer Company, Inc., 62 Grand St., New York, N. Y.

(103) SWITCHES—Technical data sheet, "Mertact" mercury electric switch in sizes from 1 to 100 amp. capacity.—CeCo Manufacturing Company, Inc., 1200 Eddy St., Providence, R. I.

(104) ELECTRICAL INSTRUMENTS—Bulletin 828, 4 pages, "Successful Operation the Keynote."—The Esterline-Angus Company, Indianapolis, Ind.

(105) VALVES—Bulletin 127, 6 pages, solenoid operated valves for air, gas, brine, water and oil.—Electric Valve Manufacturing Company, 68 Murray St., New York, N. Y.

(106) POWER TRANSMISSION — Bulletin C66, 12 pages, "Morse Pullmore" clutch.—Morse Chain Company, Division of Borg-Warner Corporation, Ithaca, N. Y.

(107) FANS—Bulletin 42, 12 pages, a.c. and d.c. stationary, oscillating, ceiling, and ventilating fans.—Century Electric Company, 1806 Pine St., St. Louis, Mo.

(108) LIGHTING EQUIPMENT — Catalog 31, 36 pages, "Garcy reflectors." In addition to a variety of equipment the catalog also contains several informative tables on distribution, intensity and color of reflectors, and recommended standards of foot candle illumination.—Garden City Plating and Manufacturing Company, 1430 South Talman Ave., Chicago, Ill.

(109) WIRE ROPE—Bulletin, 16 pages, "Twelve Reasons Why You Save Money With Lay-Set Preformed Wire Rope."—Hazard Wire Rope Company, Wilkes-Barre, Pa.

(110) CONTROL—Catalog H-7, 112 pages, automatic controls for heating equipment and industrial applications.—The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.

(111) POWER TRANSMISSION — Folder, "Ke-Ci Vacuum Cup Metal Pulley."—Keystone Engineering Company, Incorporated, 850 Maccabees Bldg., Detroit, Mich.

(112) REFRIGERATION SYSTEMS—Bulletin WJ-31-3, "Vacuum Refrigeration Systems." The bulletin describes a method of refrigeration by evaporating, under high vacuum, a portion of the water or brine to be cooled.—Foster Wheeler Corporation, 165 Broadway, New York, N. Y.

(113) COMPRESSORS — Bulletin 386, 8 pages, Sturtevant Design 9, centrifugal compressors.—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(114) MATERIALS HANDLING—Folder G-132, illustrations of tramrail systems in a variety of applications.—Cleveland Electric Tramrail Division of The Cleveland Crane and Engineering Company, Wickliffe, Ohio.

(115) CORROSION RESISTANCE—Bulletin 1506 discusses the latest U. S. Navy method of salt-spray equipment for determination of corrosion resistance, and its value to both producers and consumers of ferrous alloys.—The American Instrument Company, 774 Girard St., N.W., Washington, D. C.

(116) MOTORS—Bulletin 174, 22 pages, design and construction details of seven types of squirrel-cage motors.—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

(117) AIR FILTERS—Form 501, 16 pages, "Filtered Air—Its Importance in Building Ventilation and Air Conditioning." The bulletin deals with the subject of air contamination and its effect on man, machinery and materials from the layman's viewpoint.—American Air Filter Company, Incorporated, First and Central Aves., Louisville, Ky.

(118) DREDGE — Bulletin P6, 8 pages, description and construction details of an hydraulic pipe line dredge.—American Manganese Steel Company, Chicago Heights, Ill.

(119) INSTRUMENTS—Bulletin 1025, 16 pages, the "Tag-Mono" Indicator Recorder Catalog. Indicator recorders for automatic boiler flue gas analyses.—C. J. Tagliabue Manufacturing Company, Park and Nostrand Aves, Brooklyn, N. Y.

(120) FANS — Catalog 370, 20 pages, convertible multivane fans.—B. F. Sturtevant Company, Hyde Park, Boston, Mass.

(121) CONTROL — Leaflet, Mercoid No. 858 control for vapor-vacuum and low pressure steam boilers. — The Mercoid Corporation, 4201 Belmont Ave., Chicago, Ill.

(122) RHEOSTATS—Bulletin 12, 8 pages, models J and L, vitreous enameled rheostats, 50- and 150-watt ratings.—Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, Ill.

(123) MOTORS—Bulletin 211, 4 pages, special frame motors, dimensions and horsepower ratings.—The Ohio Electric Manufacturing Company, 5900 Maurice Ave., Cleveland, Ohio.

(124) OVENS—Bulletin Q, 6 pages, construction and operating details of the Crawford Preheater for welding castings.—The Crawford Oven Company, New Haven, Conn.

(125) STEEL WRITER—Leaflet, air operated steel writer for writing on glass and steel. — Madison-Kipp Corporation, Madison, Wis.

(126) FANS—Catalog, 48 pages, ILG propeller fans.—ILG Electric Ventilating Company, 2850 North Crawford Ave., Chicago, Ill.

(127) BUYERS' GUIDE—1932 issue Buyers' Guide, nickel alloy steel products. A directory of manufacturers, fabricators and distributors. — The International Nickel Company, Incorporated, 67 Wall St., New York, N. Y.

(128) FLOORING—Bulletin, 4 pages, Acme floor-steel.—Acme Steel Company, Chicago, Ill.

(129) DOOR OPERATORS—Folder, 8 pages, switch controlled electrical door operators for industrial and commercial uses.—Barber-Colman Company, Rockford, Ill.

(130) INSTRUMENTS — Bulletin 2321, 8 pages, "Remote Metering Equipment." Instruments which make continuous measurements at one or more points and transmit these measurements to some distant point. —The Esterline-Angus Company, Indianapolis, Ind.

COMING EVENTS

American Gear Manufacturers Association—16th Annual Meeting, Cleveland, Ohio, May, 1932. Secretary T. W. Owen, 3608 Euclid Ave., Cleveland, Ohio.

American Foundrymen's Association—36th Annual Convention, Hotel Statler, Detroit, Mich., May 2-6, 1932. Management and Materials Handling Divisions of the American Society of Mechanical Engineers will hold national meetings in conjunction with the A.F.A. G. E. Hoit, Manager American Foundrymen's Association Inc., 222 W. Adams St., Chicago, Il.

Association of Iron and Steel Electrical Engineers — Exposition and Convention, William Penn Hotel, Pittsburgh, Pa., June 20 to 23, 1932. Managing Director, John F. Kelly, Empire Building, Pittsburgh, Pa.

American Society for Testing Materials—Annual Meeting, Atlantic City, N. J., June 20 to 24. Assistant Secretary, R. E. Hess, 1315 Spruce St., Philadelphia, Pa.

Sixth Chicago Power Show—Coliseum, Chicago, June 25 to 30, 1933. Managers, Midwest Engineering Exposition, Inc., 308 W. Washington St., Chicago, Ill.

Illuminating Engineering Society—26th Annual Convention, New Ocean House, Swampscott, Mass., during the week of Sept. 26th, 1932. Assistant Secretary, Frank G. Horton, 29 West 39th St., New York, N. Y.

Flow of Water in Rubber Lined Hose

OCCASIONALLY it is necessary to know the drop in hydraulic head due to passage of water through rubber hose, hard rubber pipe, and kindred articles. Several formulas are in use for the resistance of flow in iron pipe, the generally accepted figures being those proposed by Hazen and Williams. Thus, velocity of flow in terms of pipe constants may be determined:

$$V = KC\sqrt{RS}$$

where V = Velocity in ft. per sec.

C = A constant for each type of hydraulic surface, determined by experiment.

$$R = \frac{\text{Area of wet cross-section}}{\text{Circumference of wet cross-section}}$$

$$S = \frac{\text{Pressure head in ft.}}{\text{Length of straight pipe required to run from end to end}}$$

$K = 0.0171DS$ (where D = diameter in ft. of wet cross-section).

Tables from the above, for $C = 100$ (average iron pipe in service), expressed in cu.ft. per min. and gal. per min. are available, since quantity of flow is reducible to terms of area and velocity:

$$Q = 448.8\,AV$$

Where Q = Quantity in gal. per min.

A = Area of wet cross-section in ft.

V = Velocity in ft. per sec.

Experiment has shown that for smooth bore hose, whether of mandrel cure or not, C closely approximates 140. It is of interest to note that constant correction of C is unnecessary with rubber lined conductors because rubber surface does not roughen.

The following table is thus submitted as a guide for determining choice of an installation. Where the indicated flow figures are close to minimum it will be advisable to ascertain from the rubber manufacturer the actual inside diameters of the goods. In general, mandrel cured hose may be assumed to have an overall variation from the nominal diameter of $\frac{1}{64}$ in. while internal pressure cured hose has $\frac{1}{16}$ in. variation up to 2 in. inside diameter and $\frac{3}{32}$ in. variation over 2 in. inside diameter.

FLOW OF WATER IN RUBBER HOSE, RUBBER LINED PIPE, AND THE LIKE

Loss in lb. per 100 ft.

U. S. Gal. per Min.	Size Given Below for Actual Inside Diameter in Inches										
	½	⅝	¾	1	1¼	1½	2	2½	3	4	5
½	0.5	.....	.....	.....	.....	.....	.....	.....	.....	....	....
1½	2.8	0.7	0.5	.....	.....	.....	.....	.....	.....	....	....
2½	7.6	2.1	1.1	.....	.....	.....	.....	.....	.....	....	....
5	28.5	9.6	4.0	1.1	0.4	0.2	.....	.....	.....	....	....
10	101.0	33.8	14.0	4.0	1.2	0.5	0.2	.....	.....	....	....
15	.....	70.0	30.0	8.9	2.5	1.1	0.4	0.1	.....	....	....
20	.....	112.0	53.0	14.0	4.3	1.8	0.7	0.2	.....	....	....
25	.....	.....	79.0	22.0	6.5	2.9	1.0	0.3	.....	....	....
30	.....	.....	112.0	31.0	9.2	4.0	1.4	0.4	0.1	....	....
35	.....	.....	147.0	41.0	12.0	5.3	1.8	0.5	0.2	....	....
40	.....	.....	.....	53.0	15.0	6.7	2.4	0.6	0.3	....	....
45	.....	.....	.....	66.0	19.0	8.4	3.0	0.8	0.4	....	....
50	.....	.....	.....	80.0	24.0	10.0	3.6	1.0	0.5	....	....
60	.....	.....	.....	101.0	35.0	14.0	5.1	1.4	0.6	....	....
70	.....	.....	.....	.....	45.0	19.0	6.6	1.8	0.8	....	....
80	.....	.....	.....	.....	58.0	24.0	8.6	2.3	1.1	....	....
90	.....	.....	.....	.....	71.0	30.0	11.0	3.0	1.4	0.3	....
100	.....	.....	.....	.....	88.0	37.0	12.5	3.5	1.7	0.4	0.1
125	.....	.....	.....	.....	132.0	55.0	20.0	5.3	2.5	0.6	0.2
150	.....	.....	.....	.....	183.0	78.0	27.0	7.5	3.5	0.7	0.3
175	.....	.....	.....	.....	.....	100.0	37.0	10.0	4.6	1.1	0.4
200	.....	.....	.....	.....	.....	133.0	46.0	13.0	5.9	1.4	0.5
250	.....	.....	.....	.....	.....	.....	70.0	19.0	9.1	2.1	0.7
300	.....	.....	.....	.....	.....	.....	95.0	27.0	12.0	2.9	1.0
350	.....	.....	.....	.....	.....	.....	126.0	36.0	17.0	4.0	1.3
400	.....	.....	.....	.....	.....	.....	.....	46.0	21.0	5.1	1.7
450	.....	.....	.....	.....	.....	.....	.....	57.0	26.0	6.3	2.1
500	.....	.....	.....	.....	.....	.....	.....	70.0	32.0	7.4	2.6
1,000	.....	.....	.....	.....	.....	.....	.....	.....	116.0	27.0	9.6
2,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.0	32.0

Based on Hazen and Williams formula with $C = 140$.

Courtesy B. F. Goodrich Rubber Company

MAINTENANCE ENGINEERING'S DATA SHEETS

Fire Protection

MANY engineers to whom the term "Approved by the Underwriters" has become a familiar criterion of dependability may not have a very clear conception of just who and what the Underwriters are.

The National Board of Fire Underwriters is an association of about 92 per cent of the stock fire insurance companies in the country, organized for the purpose of making latest information available to members, and of creating uniform inspection standards and protection regulations.

In 1901 it was found that the scope of the testing work had become so enlarged as to require a more formal organization. The Underwriters' Laboratories, Inc. was therefore chartered in Illinois as a corporation not for profit, and authorized to maintain laboratories for the examination and testing of devices, systems, and materials for the purpose of reporting thereon to insurance organizations.

The principal office and testing stations are located at 207 East Ohio Street, Chicago. Examination and testing facilities also are maintained in New York and San Francisco.

At a manufacturer's request the Underwriters will make tests upon sample products. Under special arrangement examinations and tests of installed equipment will be undertaken.

There are five Laboratories' Councils, officially designated as Fire, Electrical, Casualty, Automotive, and Burglary Protection. Copies of requirements and reports which are submitted to the first three of these councils are also filed with the Bureau of Standards. Final action and listing of an appliance or material by the Laboratories are dependent upon the action of the specific council concerned.

If the results of examinations and tests are such that a product cannot be recommended for listing, a detailed report is made to the submittor only.

Only products produced commercially and concerning which the actual manufacturer is known are eligible for listing, but the Laboratories may receive, examine, and test articles in the model stage and render to the submittor a report for his information and guidance in future development.

Listings are printed on cards and filed according to classifications. A copy of each card is forwarded to the submittor. The following lists are regularly published in pamphlet form:

List of Inspected Electrical Appliances

List of Inspected Fire Protection Appliances

List of Inspected Gas, Oil, and Miscellaneous Appliances

List of Inspected Automotive Appliances

List of Appliances Inspected for Accident Hazard

List of Inspected Burglary Protection Appliances

Upon notification of any features found in listed products appearing in the market believed not to be in compliance with requirements, the Laboratories will investigate and require correction in subsequent production.

Three services are furnished. *Reexamination service* consists of regular periodic examination of articles. Features not in accordance with requirements must be corrected on subsequent articles. *Special services* include all special tests and examinations not included in standard procedure. *Label service* consists of inspections of devices, systems, and materials at the factories by Laboratories' engineers and inspectors, and the labeling of goods found to conform to the requirements of the Laboratories by labels (which may be stamps or transfers). All such labels include the words "Underwriters' Laboratories Inspected."

KNOW THE SORT OF FIRE TO PROTECT AGAINST*

Type of Fire (Underwriters' Classification of Incipient Fires)	Where Likely to Occur	Most Important Requisite of Extinguishing Agent	Suitable Type of Hand Extinguisher (See Next Chart)	Do NOT Use This Type of Hand Extinguisher (Hazardous)
Class A	In ordinary combustible material, as wood, paper, textiles, rubbish, etc.	Production of quenching and cooling effect	Soda acid Anti freeze Foam	
Class B	In small quantities of rapidly burning materials, such as gasoline, oils, or greases in vats or other open vessels or on floors	Production of blanketing or smothering effect	Carbon dioxide Carbon tetrachloride Foam Dry	Soda acid Anti freeze
Class C	Electrical equipment	Non-conduction of electricity	Carbon dioxide Carbon tetrachloride	Soda acid Anti freeze

*Underwriters classification of fire extinguishers is in the form "A-1," "A-2," "B-1," "B-2," etc., as the case may be. The letters A, B, C designate the class or classes of fire for which the device is suitable. The figures following the letter designate the number of devices required to make one unit of first-aid hand protection.

CHEMICAL HAND FIRE EXTINGUISHERS*

Popular Name — Chemicals Used	Fire Where Effective	Where Use Is HAZARDOUS	Usual Method of Operation	Advantages	Disadvantages	Remarks
SODA-ACID Bicarbonate of soda dissolved in water and sulphuric acid	Class A	Classes B and C	Invert; some, of larger capacity, are pump type	Easy type to operate	Must be discharged, cleaned, recharged yearly; must be protected from freezing	About 15 different makes available. "Non freezing" compounds of any character should not be added. Addition of salt or calcium chloride to the soda solution causes the soda to precipitate, defeating the essential principle of operation; dangerous corrosion is possible
ANTI FREEZE Usually a solution of water and a special grade of calcium chloride	Class A	Class C	Invert; on some, it is necessary to invert and then to strike a plunger upon the floor; many pump types also available	Suitable in temperatures as low as 40 deg. below zero, F., in storage sheds, and other unheated buildings	Careful periodic recharging necessary	In some, the fluid is expelled by means of gases given off from an ignited charge of smokeless powder and from a slow-burning fuse; in others, by means of carbon dioxide gas from a punctured cartridge; in others, by reaction of an acid with the liquid; about 10 makes available
CARBON DIOXIDE OR CARBONIC ACID Liquid carbon dioxide	Classes B and C†	Class A‡	Usually equipped with a special quick-acting valve which punctures a "safety seal"	Especially desirable for protection of switchboards and other electrical equipment; good for rotating electrical apparatus	Cylinder must be weighed semi-annually to detect loss of liquid by leakage or tampering	About 5 makes available. Carbon dioxide is non poisonous; but in atmospheres containing concentrations sufficient to extinguish fires, it is suffocating
CARBON TETRACHLORIDE Carbon tetrachloride with special components for lowering freezing point, reducing corrosion, etc.	Classes B and C	Class A	Hand pump	Low freezing point (—50° F.)	Must be partially discharged and refilled yearly; dangerous toxic effects of vapors in confined places; may destroy electrical insulation	About 12 makes available
FOAM Blanket of foam, containing carbon dioxide bubbles, produced by reaction of bicarbonate of soda and a foam producing agent dissolved in water in outer compartment, with aluminum sulphate dissolved in water in inner compartment	Classes A and B	Class C	Usually by inverting	Excellent for fierce fires; residue, a dry powder, may be easily brushed away; no damage to equipment	In low temp. must be protected against freezing; must be charged, cleaned, and recharged yearly	When freshly charged and at 70 deg. F., these devices usually discharge approximately 1 cu.ft. of foam per gal. rated liquid capacity; about 20 makes on the market
DRY Specially prepared powder, whose chief ingredient usually is bicarbonate of soda	Class B	Underwriters have not completed tests of applicability to A and C types	Scattering dust on fire§	Clean; non poisonous; smothers fires rapidly; does not freeze; does not injure fabrics	Protective qualities not yet officially established by Underwriters	Very few makes on the market

*Much of the material in this chart has been condensed from information published by the Underwriters' Laboratories.
‡Not hazardous here—simply not adequate protection because gas may be dissipated and its smothering effect destroyed.
†Where conditions permit close approach to burning area.
§Large type available which expels dust by means of nitrogen.

Causes of Heating of A. C. Solenoids

ONE of the characteristics of an a.c. solenoid is its high inrush current. The current may be nineteen or twenty times the magnetizing current that flows after the solenoid has sealed. Therefore, whenever an a.c. solenoid overheats, the cause of the trouble may be due in some way to the inrush current. The following possible sources of trouble should be investigated:

1. See whether the solenoid core seals every time the coils are energized. Some foreign substance may be preventing the core from pulling completely home. Referring to curve *a* in the chart, it will be seen that at zero gap, normal voltage, the current is slightly less than 1 amp., but with a gap of only $\frac{1}{8}$ in., the current is still more than twice this value. For higher gaps the current is greater, and the heat generated increases proportionately much faster than the increase in current.

2. Check the duty being performed by the solenoid. If it is being worked on a very fast cycle of operations, where the coils are being energized and de-energized very rapidly, the inrush current may be existing for such a large proportion of the time as to cause overheating.

3. Some solenoids are equipped with auxiliary switches. The solenoid may be so designed that it is necessary to have the current materially reduced by inserting resistance in series with the coil after it has sealed, so as to reduce the current in the coil. If the switch is not operating every time the solenoid seales, it may be causing the coil circuit to carry more current than it should.

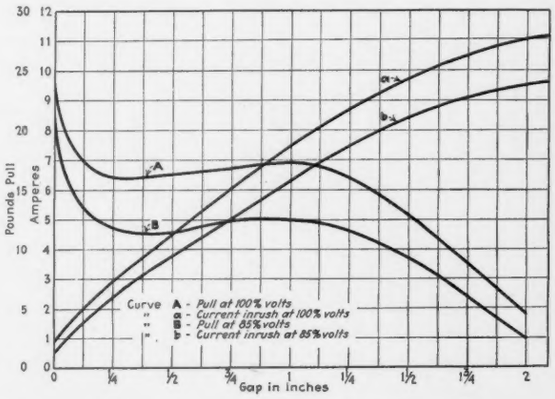
4. Some solenoids are equipped with dashpots to prevent them from slamming. If there is too much dashpot action, it may cause the inrush current to last too long and cause overheating. Also, the dashpot may be out of adjustment and prevent the solenoid from sealing.

5. The iron of the solenoid may have been injured so that the magnetic circuit is imperfect. This will have the same effect as failure of the solenoid to seal and cause excessive current flow in the coil.

6. Check the rating of the solenoid for voltage and frequency. If the solenoid is designed for a lower voltage or a higher frequency than the circuit to which it is connected, it will overheat.

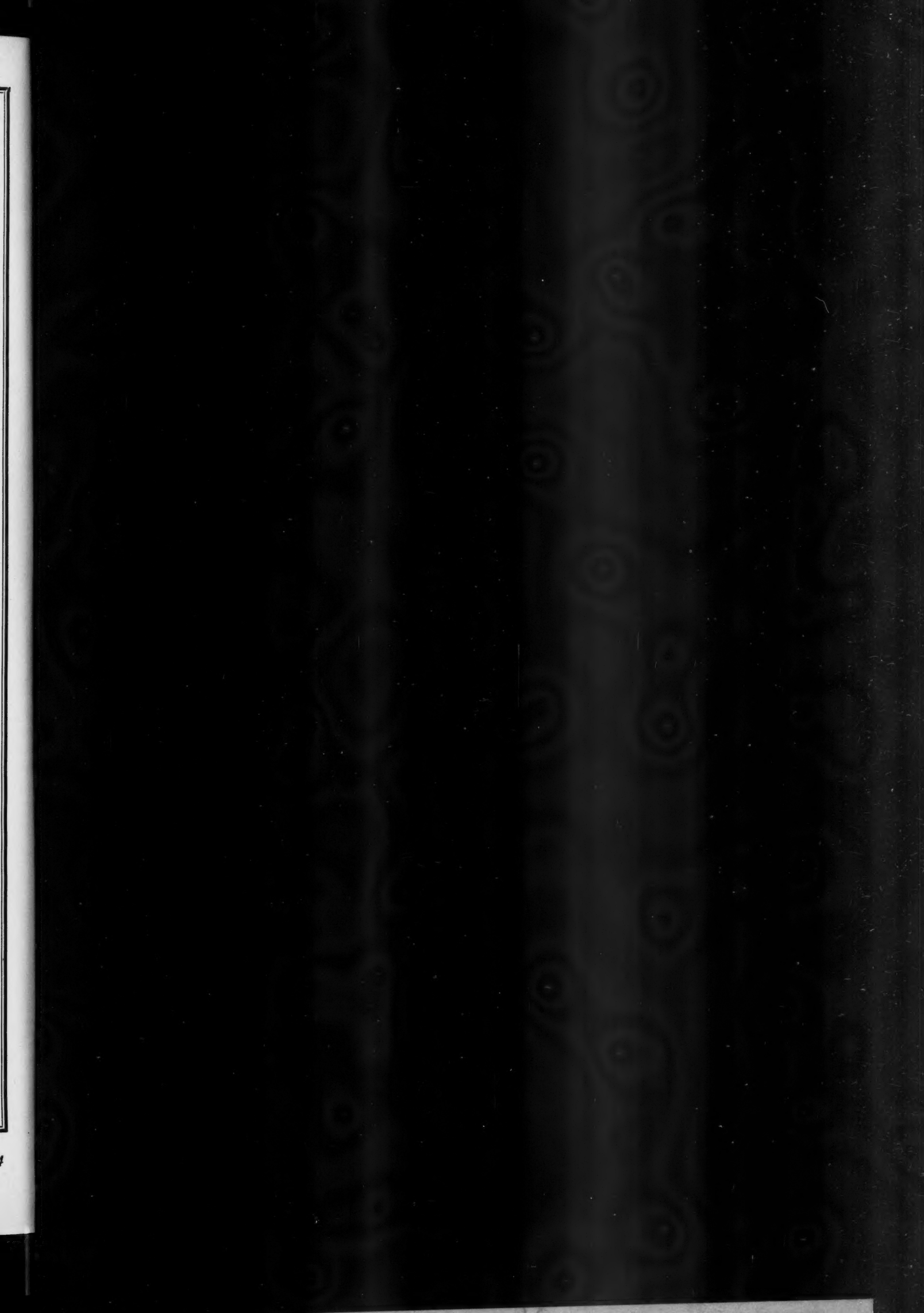
7. Check the voltage at the solenoid terminals. If excessively long leads of small cross-section are used there may be a large voltage drop, and the pull of the solenoid may be too low to cause it to seal every time. The pull decreases as the square of the voltage. If the voltage is 85 per cent of normal, the pull is only about 72 per cent of what it is supposed to be, as indicated by curves *A* and *B* in the chart.

8. If the voltage is low, change the line connections to the taps of the solenoid (if they have any).


Pounds Pull
Amperes
Gap in Inches
Curve A - Pull at 100% volts
" a - Current inrush at 100% volts
" B - Pull at 85% volts
" b - Current inrush at 85% volts

Typical performance curves for 60-cycle solenoid.

In the case of brakes this will make the action quicker and reduce the time that the high current exists.

9. The air gap may have become excessive due to wear of brake shoes or other parts. On some brakes, the adjustment of the air gap is supposed to be done by hand and on others it is taken care of automatically. If the air gap is excessive and is not adjusted, it may cause trouble.

Submitted by R. F. Emerson, Industrial Engineering Department
General Electric Company, Schenectady, N. Y.